ELECTRONICS Australia

HIFI NEWS

MAY, 1975
AUST 80c* NZ 80c

LOW COST SOLAR CELLS: HOW SOON?

PAL-S DECODER

BUILD YOUR OWN SLAVE FLASH, CALCULATOR

THE NEW
POWER FET AMPLIFIERS

Registered for posting as a periodical — Category B

ELECTRONICS Australia

Australia's largest-selling electronics & hi-fi magazine

VOLUME 37 No 2

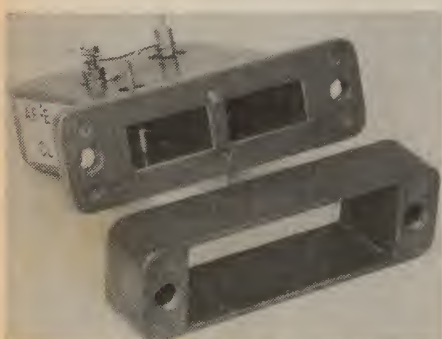
CONTENTS — MAY 1975

world of electronics and hi-fi

projects and technical

regular features

Developed in our laboratory, this versatile windscreen wiper control unit is simple to construct and can be fitted to almost all types of cars. Full constructional details commence on page 34.



This 10GHz twin transmitter/receiver Doppler radar module recently released by Philips Elcoma is suited to a wide range of applications. To illustrate just one of these applications Elcoma made up a simple intruder alarm, the details of which are provided in our article on page 64.

On the cover

Our cover this month depicts a selection of high quality Yamaha stereo equipment as distributed in Australia by Rose Music Pty Ltd, 17-33 Market St, Melbourne. Inset shows one of the new generation stereo amplifiers using power FET transistors in the output stages. Details of this new breed of power amplifier are given in our feature article commencing on page 14.

PHILIPS

PHILIPS

If it moves, Doppler can detect it.

low cost–wide range–high reliability

Doppler miniature radars, for the local detection of moving objects, can be readily designed and manufactured with our microwave modules.

A typical example is the twin cavity X-band Doppler transmitter-receiver, CL8960. It incorporates its own antenna, yet it is small enough to be held in the palm of your hand.

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Please supply me with more information on your Doppler systems. I am particularly interested in..
(type of application)

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ELCOMA

Editorial Viewpoint

Colour facts and fancies

Not surprisingly, there has been a dramatic increase in colour TV promotional activity since regular colour transmissions began in March. Most of it has been initiated by the two main vested-interest groups: the broadcasters and the set marketers. At times it has been hard to decide which group has been the more frenzied—the former with their attempts to whip up viewer demand, or the latter with their attempts to build, borrow or import enough sets to satisfy the demand!

I suppose it was inevitable that we would get a spate of dubious and misleading claims and assertions during this period, despite the recent introduction of legislation designed to curb such abuses. The main effect of the legislation seems to have been to force those making claims to be more vague and ambiguous.

For example one of the leading manufacturers has run many times an advert claiming that its sets produce "the most natural colour in the world", despite the fact that they employ virtually the same colour kinescopes and PAL-D circuitry used in many others. Another manufacturer claims that its sets use "a delta-mask tube, for the picture the others would like to have", making a virtue out of a tube technology now generally acknowledged to be obsolescent. Still another advertisement proclaims proudly that an imported set uses the PAL-bypass system for true-to-life colours!

Some of the broadcasters haven't been entirely sincere, either. I've almost lost count of the comments by announcers or comperes implying that the vast majority of viewers are already viewing in colour. This despite the fact that as yet fewer than 5% would be in this position. This is either wishful thinking, or a deliberate attempt to exert pressure on viewers by setting up a fictitious majority of "Joneses" against which one should supposedly be competing.

But perhaps the most misleading story of all is apparently being propagated by salesmen in some retailers, and also in modified form by some hiring firms. Within 5 years, so the story goes, all colour TV transmissions are to be shifted into the UHF band, so that any colour set without a UHF tuner will become useless.

Presumably this quite false and misleading story stems partly from a vague and distorted awareness of ABCB planning and advice concerning future extension of TV broadcasting into UHF channels, and perhaps partly from "analogy" with the UK change from VHF to UHF.

The benighted salesmen peddling the story are apparently unaware that our situation is quite different from that in the UK, where they needed to change both the picture transmission standards and the band. In our case there is no intention of shifting all TV broadcasting into the UHF band, merely the provision to expand into it when necessary. And in any case, when the time comes, virtually any receiver may be adapted for UHF reception by the addition of a low-cost converter.

I hope that readers of EA will try to counter the misleading tales and rumours, where possible, by suitable reference to facts. No firm, or industry for that matter, can survive for long by promoting falsehoods.

—Jamieson Rowe

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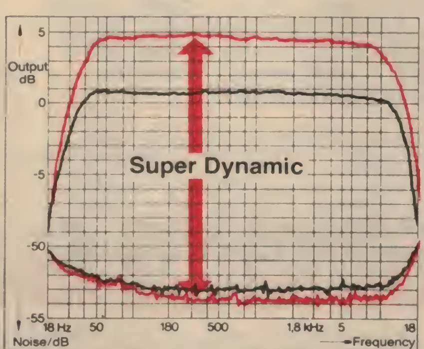

Performance specifications of the higher quality cassette decks are exceeded, the reproduction of any recorder is improved.

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BA4472

Hi Fi News

Spring reverb—with a difference!

A revival of interest in spring reverberation units for hifi systems would seem a most unlikely development, were it not for one thing: the interest is being sparked by AKG, makers of quality microphones and a company known and respected around the world.

A few months ago, AKG in association with Philips, hosted a party of internationally known hifi writers and critics, in order to show off various new and interesting product lines. Curiously, one that grabbed a large share of attention was a spring reverberation unit! It happened this way:

Without being forewarned the writer/tourists were invited by AKG engineers to listen to a good quality but otherwise normal stereo system playing the Bruckner 7th Symphony. It was pleasant but not in any sense spectacular.

Then the AKG engineers brought into action loudspeakers in the rear corners of the room, in what seemed superficially to be a conventional quadraphonic setup. The difference was that the rear loudpeakers, in this case, were being fed with front signals, delayed 30 milliseconds in an AKG digital delay system. The extra, delayed signal lent a new perspective to the overall sound but, while the audience voted it better than straight stereo, it was still hardly sensational.

Next, the engineers cut out the digital delay unit and substituted AKG's torsion transmission line (TTL) which happens to be a fancy name for a spring reverberation unit. As a unit, it was obviously a good one and its 2.5 seconds delay gave a different perspective—but again hardly sensational.

Then both units were cut in, giving both short and long delay and the immediate effect was voted as being acoustically little short of sensational. To quote Bert Whyte of "Audio" magazine: "... the walls of the room did indeed seem to fall away, giving a tremendously enhanced concert hall perspective to the sound. This was pseudo quadrophony of a very high order, and it was hard to believe that a stereo recording could be processed to achieve such a thrilling and very desirous sound. Why, this would revitalise even the oldest of stereo recordings."

The overall effect of the demonstration was apparently to produce a batch of hifi enthusiasts, with a healthy new respect for synthetic reverberation, and embryo plans for getting their hands on the necessary (and expensive) units to doctor their own music systems.

More than anything else, the collective enthusiasm must be seen as a tribute to the designers of the new AKG torsional transmission line, in their ability to revitalise an old and limited technique.

As many will know, spring reverberation units have been around ever since the Hammond company added them to electronic organs. Used discreetly under the control of the player, such units can add a welcome reverberant quality to the otherwise bland sound of a typical electronic organ used in a typical living area.

Conventional organ spring units range from about 20 to 50cm in length and contain two deliberately different spiral springs anchored between pairs of magnetic transducers. Signal is fed to the springs at one end, then picked up at the other, amplified and fed to loudspeakers. Some of the simpler reverb units have only a single spring.

While the makers of such units try to minimise and disperse bandpass and resonance effects, they still represent a problem—tolerable only if the reverberated signal is kept subordinate to the main signal. If the reverberation system is too prominent, the sound takes on a quite artificial quality which has been described eloquently as "boing"!

About 15 years ago, STC Australia tried to capture a slice of the local stereogram market with a model which featured inbuilt reverberation. The venture proved a failure commercially but it was a bonanza for local organ enthusiasts who were presented with an oversupply of excellent Hammond/Rola reverb units at a fraction of their normal market value.

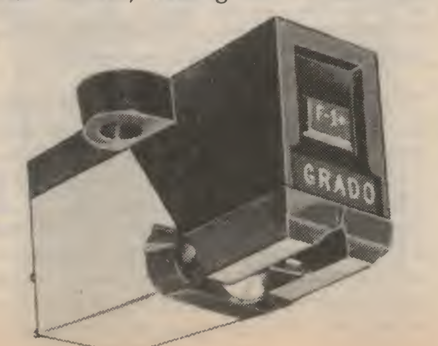
What made the difference between a bad idea for STC and a potentially good one for AKG?

Two things: AKG used reverberation to project ambience from behind the listener, rather than via the front loudspeakers. And AKG have a very carefully engineered (and very expensive) unit which seemingly earns its fancy title.

In the AKG unit individual coils of the two springs are bent, or pushed together, or spread apart in a statistically determined way, to prevent the build-up of resonance effects in any one frequency region. This looks after the response up

GRADO CD-4 COMPATIBLE PHONO CARTRIDGES

The F+ series of pickup cartridges is Grado's answer to the contention that no single cartridge can do justice to CD-4 records as well as to ordinary 2-channel and 4-channel matrix discs. Grado claim that their F+ series cartridges have uniquely low mass and high compliance, making them much less reliant than normal on special stylus shapes to track frequencies above the audible range. In addition, they have a lower inductance than normal, making them much less sensitive to the effects of cable capacitance and amplifier input impedance.



The least expensive in the series are the "Professional" types FTR+ and the FTE+, available respectively with spherical and elliptical styli; Grado claim that they are more than competitive with other 40kHz cartridges on the quality market, intended for arms needing a playing weight of 2-3 grams.

The FCR+ and FCE+ are selected units from the Professional production run, for top-of-the-line performance.

The "Flux Bridger" models FTR+1 and FCR+1 have a different internal generator system, a response to 50kHz and a normal tracking weight of 1-2 grams.

Above them again in the range is the "Super Flux-Bridger" series F3E+, F2+ and F1+, all with elliptical diamond stylus and a recommended tracking weight of 0.75 to 2 grams.

For further information: H. Rowe & Co Pty Ltd, in all capital cities or at 127 Victoria Road, Marrickville 2204.

to about 1kHz.

To produce a similar effect at the higher frequencies, the wire is dented by distributed spot etching which produces thousands of discontinuities along its length. Something like 20% of the wire is removed by this treatment but the end result is a reverberated sound which is reportedly extremely natural and notably free from traditional spring reverb "boing"!

But there is a catch: Whereas Hammond style reverb units and scaled-down copies have commonly changed hands for a few dollars a time, the AKG torsional transmission line has a current price tag of some hundreds of dollars. At this price, they might be a proposition for commercial concerns reworking old recordings but they're hardly a proposition for individual quadraphonic enthusiasts.

But the thought is there. If AKG could cause a group of hard-bitten hifi writers to sit up and take notice with short and long time delayed signals fed into the back channels, it must pose a challenge to local enthusiasts to achieve a similar reaction with the limited means—and dollars—at their disposal!

"SHARP" CASSETTES: The latest radio/cassette players announced by the Sharp Corporation are sharp by design as well as by name. Their model GF-77M has a wide band tuner capable of covering adjacent television sound channels as well as the full international FM band. What is more, it is possible to set it up so that it will record a program via the FM facility, while the user is actually listening to an AM station. The reverse is also possible. For good measure, it incorporates provision for microphone mixing, full auto-stop facilities and a "clock system" counter which indicates the amount of unrecorded tape.

The Sharp model GF-11M contains the APSS facility, which stands for Automatic Program Starting System. With this system, the transport mechanism will operate in fast forward mode and stop automatically at the head of each new item, presumably triggered by the silence break in between. This model also has de-luxe audio features such as independent bass, treble and loudness controls, microphone mixing, high-output 2-loudspeaker system, automatic or manual recording facilities; metering for tuning, recording level and battery voltage; auto-stop provision, pause control and "sleep" switch.

HIFI ADVERTISING: Prompted by huge numbers of complaints from consumers, the U.S. Federal Trade Commission came out with a strict set of rules governing the way in which hifi equipment specifications must be determined and presented to the public. The objective was to rule out fancy descriptions and artificially jacked-up figures.

The industry generally welcomed the measures but there were many complaints that the F.T.C. had gone too far and demanded testing procedures that were to the disadvantage of amplifiers which had genuine qualities to offer, such as an enormous reserve of peak power to cope with transient peaks. But the Commission has been adamant (some called it stubborn) and the rules stand.

The major problem at the moment is not with major manufacturers or the professional journals, all of whom are close enough to the action to know what is right and wrong. It is with retailers, advertising agencies and newspapers or non-professional journals who remain blissfully unaware of the Commission's crack-down.

At the moment, the authorities are being "understanding" about breaches but a tougher period is ahead. Anyone who offers hifi gear simply has to learn that claims like "super power" and "big sound" are out; that figures quoted must contain the statutory information—in the form specified—in spelt out words.

COPYING RECORDS: If there is a furore in America about "pirate" cassettes marketed outside copyright obligations, another one of a different kind is building up in Japan. There, virtually 50% of all households own a tape recorder of one kind or another, with a high proportion of cassette radios. Not surprisingly, there is a strong upward tendency in the consumption of both pre-recorded and blank cassettes. Long-playing discs are still doing well also but sales of single discs are faltering badly by comparison.

Record manufacturers are concerned by this shrinking one-time lucrative market and are blaming copying by private individuals, off-air, or off borrowed discs. Traditionally in Japan, as in many other countries, recording of copyright material for individual use has been tolerated and conceded "legal" status. But mass infringement of copyright by individuals poses a challenge of a different order and pressure is mounting for a more stringent interpretation of the law. First obvious target would be listener groups or cooperatives who buy individual recordings, which are then passed around.

NON-DIAMOND STYLUS: Prompted by the cost and reliance upon imports of quality diamonds, Toshiba and Nagaoka have jointly developed a new, long-life, low-cost stylus which is being marketed under the name "Ultra Extend Stylus". The stylus is based on artificial "corundum" crystal whose main ingredient is aluminium oxide. Under X-ray examination, the direction of the crystalline structure can be identified and controlled so that it exhibits the greatest possible resistance to abrasion.

Information about the physical shape of the new stylus is sparse at this stage but it would appear to be multi-radial and designed to play both 2-channel and 4-channel records.

NEW NAKAMICHI PORTABLE CASSETTE RECORDER

Having gained a great deal of attention with their super quality 3-head cassette decks for professional and domestic use, Nakamichi have now released a high quality portable deck—again with ambitious specifications. It is a 2-head machine with a response to 17kHz (+ and −3dB), a signal/noise ratio better than 60dB (Dolby in), harmonic distortion 2% (typical), and a wow/flutter of 0.13% WTD peak. Identified as model 550, it can operate from internal dry cells, car battery or mains supply, internal regulation taking care of any voltage variations. It has the usual tape travel controls but the indicator and cueing facilities, level meters and such like are in line with professional standards. Dynamic range of the microphone input circuits is 120dB. For further information: Nakamichi Sales, Magnecord International Pty Ltd, 276 Castlereagh Street, Sydney 2000.

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In Australia today three particular Wharfedale speaker systems enjoy an ever growing demand — they're reasonably priced and completely compatible with all transistorised amplifiers. Listen to the audible difference Wharfedale experience makes when you visit your hi-fi specialist store — *and compare the performance!*

"LINTON 2". With a frequency response of 55-17,000 Hz. ± 3 dB. and a power handling capacity of 20 watts DIN, the compact "Linton 2" features a specially designed and sensitive 20 cm bass/mid range reproducer and a 5 cm high frequency unit. Size is only 48 x 25 x 24 cm. Ideal for floor or shelf. In teak and walnut finishes.

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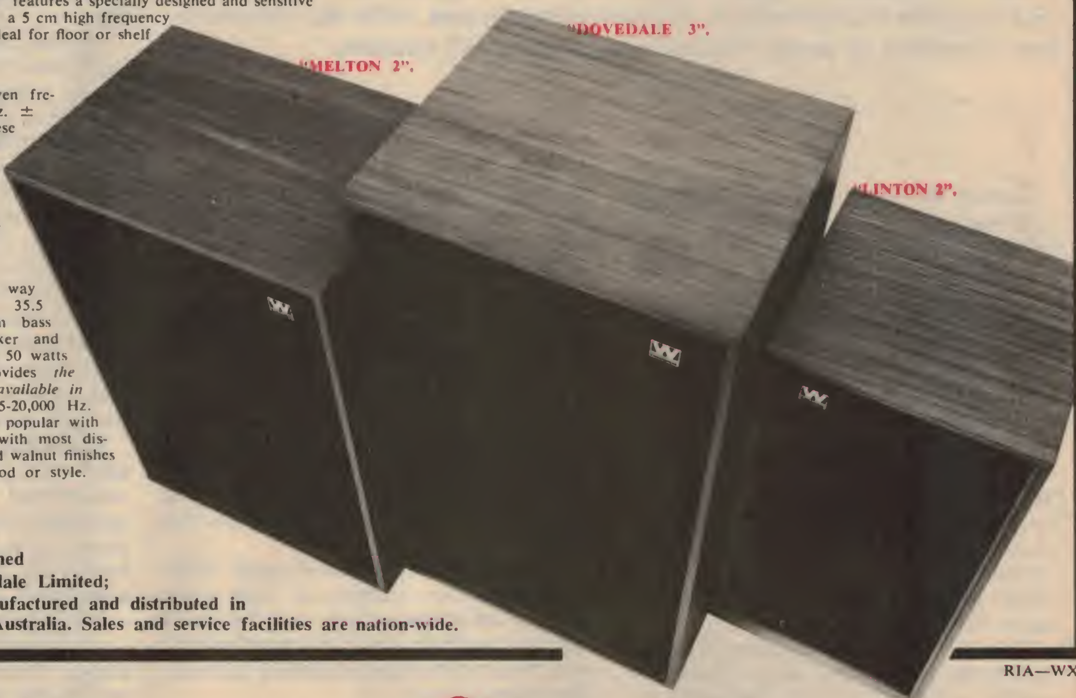

Wharfedale speakers are designed in the U.K. by Rank Wharfedale Limited; these fine reproducers are manufactured and distributed in Australia by Rank Industries Australia. Sales and service facilities are nation-wide.

RIA—WX3

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Power FETS usher in a new breed of HiFi Amplifier

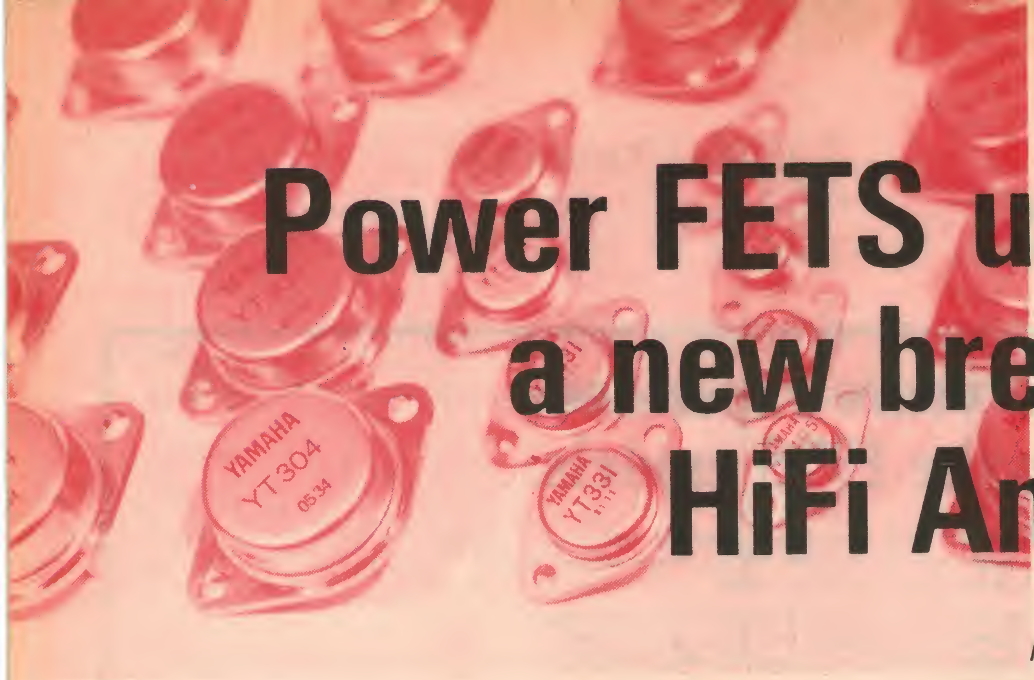


Fig. 5.

As we indicated in our March issue, the emergence of commercial field effect power transistors—power FETs—is likely to have an important bearing on the future design of high fidelity amplifier systems. Power FETs would appear to combine the ruggedness, convenience and long-life characteristics of solid-state devices, with the inherently low distortion of power valves in traditional hifi circuitry.

by NEVILLE WILLIAMS

During the past decade, solid-state amplifiers using ordinary bipolar transistors have come to dominate the hifi market offering, as they do, high power output and ostensibly excellent results from units that are far more reliable, compact and cooler running than would ever have been possible with valve technology.

It is undoubtedly a tribute to designers that they have achieved these plus factors in the face of considerable difficulties, most of them originating with the bipolar transistors used in the output stage. All such transistors are inherently thermally unstable: a rise in temperature tends to produce a rise in current, which further raises the temperature, which further raises the current, etc.

To make matters worse, the rising current tends to concentrate or "lump" in certain regions of the chip, hastening the process towards self-destruction.

To safeguard the transistors, designers have to provide generously proportioned heatsinks along with thermal and direct current feedback—adding considerably to design and circuit complexity. But that is not the end of the matter.

As further insurance against temperature rise, designers have opted almost universally to operate the output transistors in class-B mode, with a quiescent current of only a few milliamps. In so doing, they have to face up to non-linearity in the crossover region where the output current is being transferred, on successive half cycles, from one transistor to the other. The problem can be minimised but rarely eliminated altogether, being further complicated if transistors are used in parallel to up the power rating.

The end result is an output system which, apart from thermal and DC complications, has two potential sources of distortion, characteristic of all class-B audio amplifiers: (1) drivers which have to deliver significant power into a low and non-constant impedance and (2) output devices which pass in and out of conduction on each alternate half cycle—this into a complex, highly reactive load!

In its natural state a class-B stage—valve or transistor—is unlikely to meet even modest hifi requirements and designers rely on very heavy negative feedback to reduce the distortion, hopefully to negligible proportions.

To be fair, it must be admitted that the distortion figures for modern, quality amplifiers are indeed very low. As a bonus, output impedance is also low and frequency response notably flat way beyond both ends of the audible spectrum.

But the whole approach has its critics. Designers themselves would prefer not to rely as heavily as they do on negative feedback, with its tendency to be least effective in the crossover situation where it is most needed. They would prefer, if they could, to produce a system which is instrinsically good "as-is"—without feedback—then use feedback as an added refinement.

Many will recall that this was the philosophy towards the end of the valve era, when power triodes and pentodes in ultralinear configuration were popular and capable of excellent results, feedback or no feedback.

Confirmation for this "boffin" conviction can probably be found in the occasional super-quality solid-state amplifier, which shows up in the marketplace or in the literature, using bipolar transistors in class-A—despite the very formidable design difficulties involved.

An unfortunate aspect of class-B transistor operation is that the crossover distortion tends to have a fairly constant amplitude, irrespective of signal level. When compared with the total signal at

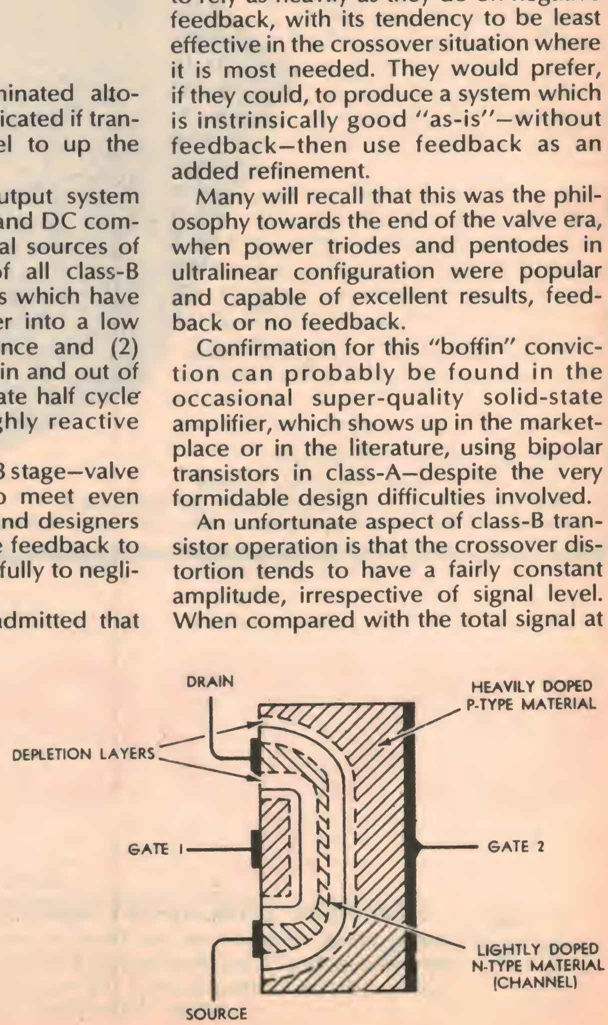


Fig. 1: Illustrating the basic principles of a small-signal N-channel FET. The long, narrow channel produces drain output impedance curves similar to those of a pentode valve, not well suited for an audio output stage. The new "vertical" configuration lowers output impedance and increases dissipation.

full power, the distortion content may be very small, so that formal tests yield a commendably low THD (total harmonic distortion) reading. But this a rather artificial situation.

In everyday use, high fidelity amplifiers operate on program material far below their maximum power rating; on soft passages, the output may diminish to a fraction of a watt. Critics maintain that, compared with output of this order, a constant amplitude of crossover distortion may represent an unacceptable THD percentage, being rendered the more objectionable by the presence of higher order harmonics, resulting from the "switching" action.

They maintain that the distortion can be discerned in some circumstances, being evident as a subtle harshness, particularly in low level sound.

If admitted as a significant problem, crossover distortion would seem to be interlocked with loudspeaker efficiency—with sensitive systems at a disadvantage, because every extra dB of sensitivity would expose an extra dB of the constant amplitude distortion. It leads to speculation as to whether insensitive systems may have been preferred on occasions, not for their intrinsic merit, but because they helped bury a distortion problem!

While it is difficult to debate or quantitise the subjective effect of distortion, one thing is certain: with high quality valve amplifiers, distortion tends to diminish both in absolute amplitude and percentage as the operating level is reduced, being at its lowest in soft musical passages, and with a minimum of objectionable high order harmonics. What is more, the use of a sensitive loudspeaker system helps matters further, because it allows the amplifier to operate at an even lower power level, while, of course, ensuring higher acoustic output on peaks.

In all this, there is unlimited scope for claim and counter-claim but, in the highly subjective and emotional world of hifi sound, the arguments provide a very favourable climate for the introduction of a new device which promises to combine the best of both technologies—the convenience, efficiency and durability of solid-state with the low intrinsic distortion of the almost proverbial class-A valve output stage!

That device is the power field effect transistor; for short, the power FET. It is being heralded by some as a device that looks like a transistor but acts like a valve!

While it is natural to draw comparisons between power FETs and power triode valves, the theme can be overdone. The power FET is not the outcome of an attempt to produce a solid-state valve. It is a device in its own right, with its own special advantages, which would probably end up in the same kind of circuitry, even had valves never existed. It just so happens that the two lend themselves to similar circuit application, and on this basis, comparison is valid.

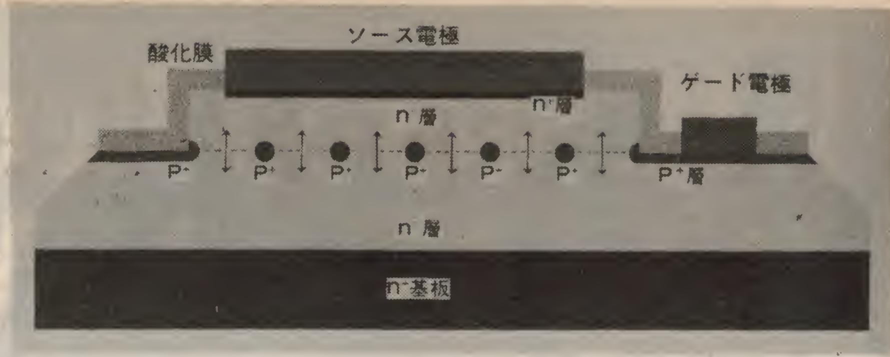
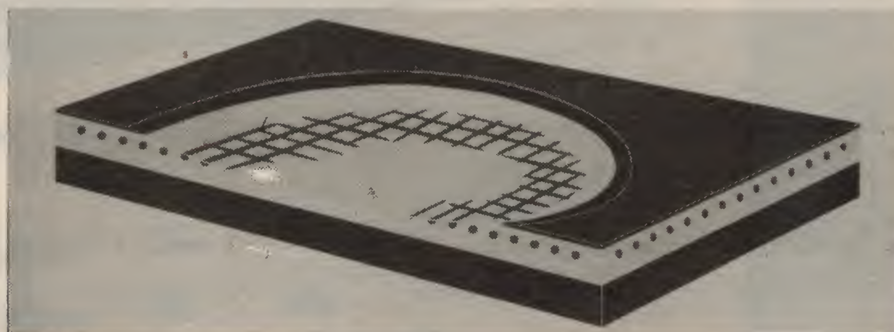


Fig. 2: Supplied to E.A. by Yamaha—complete with Japanese labels—this diagram illustrates the principles of the new "vertical" power FET, in this case N-channel. A lattice of positively doped material is implanted in N material acting as a gate. The N material above the lattice (as depicted) forms the source; that within the lattice (arrowed) the multiple channels; and that below, the drain. The dark regions at top and bottom are the heavily doped "contact" zones for source and drain.



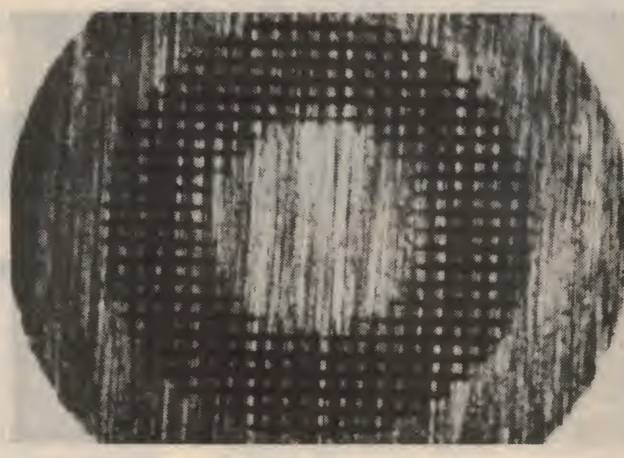


Fig. 3 (above) is an artist's sketch of what a power FET chip would look like if a hollow were ground in the top, through the contact and source zones, through the gate lattice into the drain. Fig. 4 (right) is an actual microphotograph of a chip which has been subjected to this treatment.

In a valve, current flows across the vacuum between a cathode and anode, the quantity of current being controlled by the intervening grid. The grid does not normally draw significant current, so that the input impedance to the stage is high and constant. As a result, while the preceding amplifier stage(s) must provide an adequate signal voltage, they can operate as straightforward low-disortion voltage amplifiers.

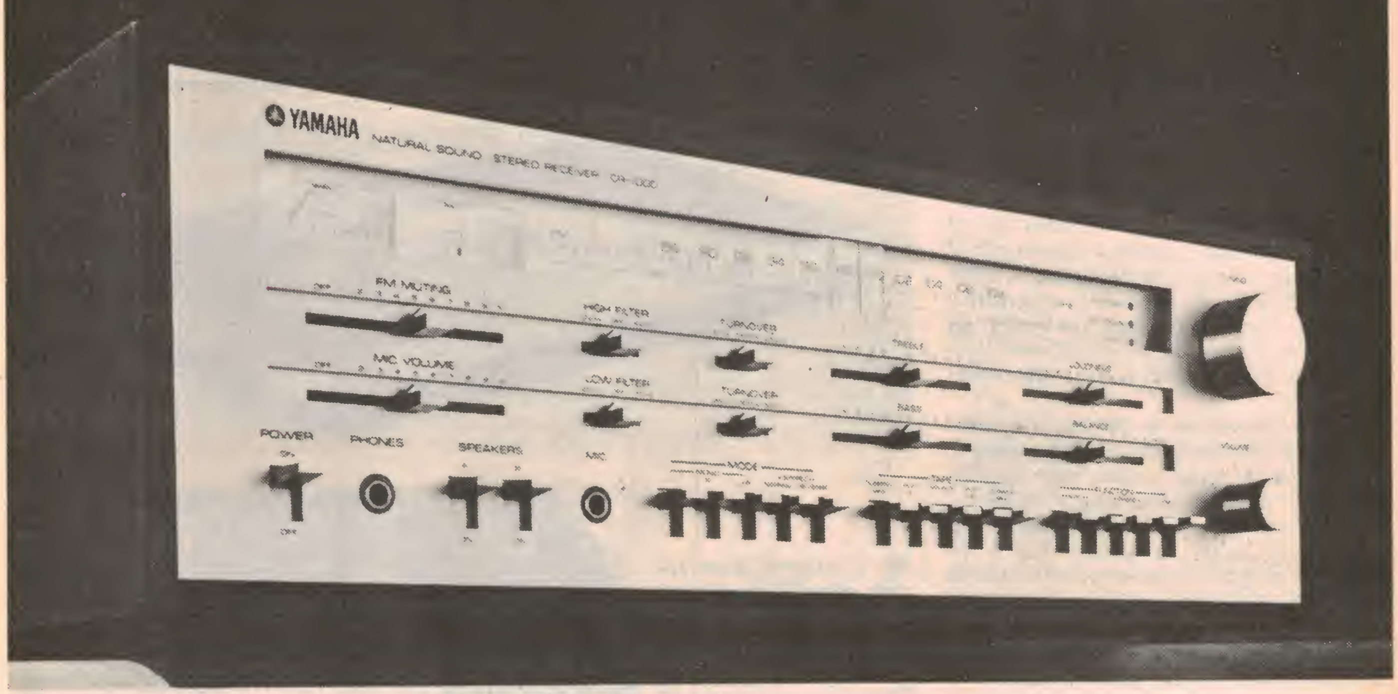
More importantly, it is convenient to operate a valve output stage under class-A or class-AB1 conditions, with both valves drawing substantially normal current, irrespective of the amount of signal being handled. Under dynamic conditions, both valves contribute to the output over the cycle and there is little or no discontinuity in the flow of output signal current.

With a non-critical drive requirement, no output current discontinuity and with the push-pull connection substantially cancelling even order harmonics, the intrinsic or "as-is" distortion of such an output stage is quite low. It can be made even lower by the use of negative feedback, without ever needing to use so much feedback that it begins to endanger stability.

There is every reason to believe that the new FET power transistors can accommodate to this kind of circuitry with important additional advantages: (1) Being a low impedance device, they can operate directly into loudspeaker voice coils and (2) they can be used in circuit configurations not practical with valves.

As opposed to bipolar types, field ef-

F.M. Stereo Reception, Why Yamaha Waited.



Australia, wisely, has adopted International Standards and Specifications for F.M. Transmission and it would not be difficult for any competent manufacturer to design and produce an F.M. Receiver to meet these specifications.

But receiving a F.M. signal is one thing. Converting that signal into an almost perfect reproduction of the transmitted sound is another.

So Yamaha waited. And whilst they waited they worked — hard.

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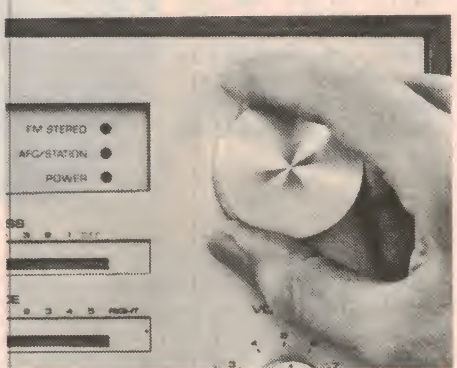

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For brochures giving you full details and specifications of the new range of Yamaha Stereo FM/AM Receivers with Dual Tuning Meters and Mic Mixing — CR 400, CR 600, CR 800, CR 1000 — complete and post the coupon on this page.

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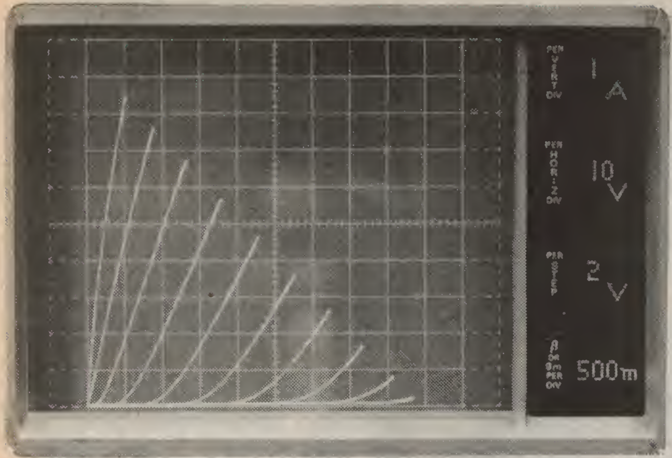


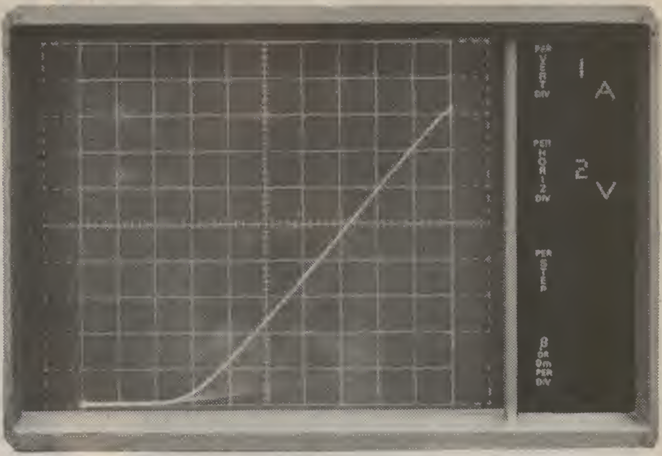
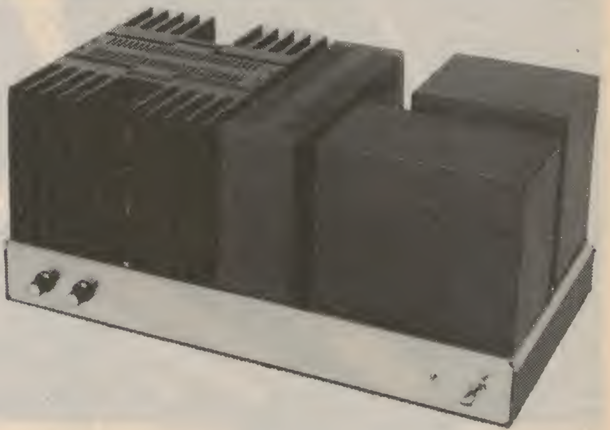


Fig. 6 (above) is an oscillographic plot of a family of drain curves for a typical Yamaha power FET. The resemblance to a power triode plate family is apparent. Fig. 7 (top right) is a linearity plot for a power FET.



A Yamaha basic power amplifier using a pair of YT304 power FETs in the output of each channel, in a single-ended push pull configuration. They are preceded by four smaller YT405 power FET drivers.

fect transistors, large and small, tend to be thermally self-protecting, as increasing temperature produces a reduction in the current through them. The characteristic is particularly important in the new breed of FET intended for high power applications; while they still need heatsinks to combat temperature rise, circuit configuration and complexity is no longer dictated by the fear of thermal runaway. It becomes much more practical to operate a FET output stage under class-A or -AB conditions, thereby obviating the basic problem of crossover distortion, as well as cancelling even order harmonics.

Nor is it just a matter of quiescent current and elimination of crossover distortion. As we shall see later, the new power FETs have an intrinsically low output impedance, the counterpart of a power triode. As such, they are much more compatible with a reactive (e.g. loudspeaker) load than a bipolar transistor or a pentode valve.

As far as drive requirements are concerned they suffer the drawback that they exhibit high input capacitance, typically reckoned in thousands of pF. Thus, while the pre-output drivers do not have to cope with a non-linear load, as for a class-B stage, they do have to operate at quite low impedance and therefore draw significant current. The drivers most favoured seem to be smaller scale power FETs.

As with any class-A or -AB system, the power supply must be capable of supplying a consistently high current, more or less independent of output level. However, because the current is constant and because power FETs tend to be self-protecting, the need for supply regulation is either reduced or eliminated.

Details aside, however, power FETs would seem to offer to designers an important new approach which exhibits lower intrinsic distortion, relying much less on negative feedback to correct any shortcomings.

While power FETs are a relatively new development, the basic concept of the field effect transistor is quite old. It was first suggested in 1928 by American engineer Julius E. Lilienfeld, and patented in 1930. The first commercial germanium field effect transistor was developed in 1958 by the Polish scientist Stanislaud Teszner in the laboratories of the French firm Companie Francais Thompson-Houston. A silicon version produced by the American firm Crystalonics Inc, two years later, set the stage for commercial exploitation.

Small signal FETs have been used for some years in the front end of VHF TV, FM and communications receivers, but high power development and application proved more elusive. It is only in the last few months that they have emerged in significant commercial quantities.

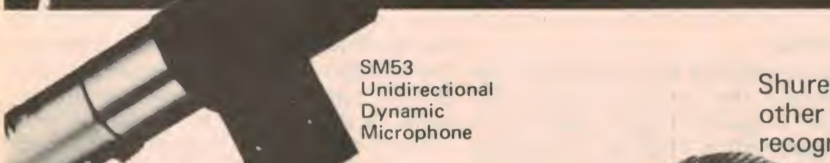
Most of the recent activity in power FETs has flowed from the work of Professor Junichi Nishizawa, of Tohoku University, under commission from the Japan Technology Development Foundation. Commenced in 1969, it was taken up by companies like Nippon Gakki (Yamaha), Nippon Electric and Sony, who produced their own versions. Sony in particular are using the term "V-FET".

Equipment manufacturers also began developmental programs and the period 1973/4 saw the unveiling of prototype FET amplifiers by such companies as Matsushita, Trio/Kenwood, Pioneer, Toshiba, JVC and Sharp. The current year should see the commercial release of quite a few big-name amplifiers with class-A FETs in the output stage—and more arguments as to whether the valve has at last been successfully challenged in the purist domain!

The basic principles of ordinary FETs have been covered in detail by Editor Jim Rowe in the "Electronics Australia" handbook "Fundamentals Of Solid State".

Fig. 1, taken from this book, illustrates the structure and operation of a small signal silicon N-channel junction FET. Produced by ordinary etching, diffusion and allied techniques, a U-shaped channel of lightly doped N-type material is enclosed between the body of the chip and another smaller region, both of heavily doped P-type material. Because current carriers tend naturally to retreat from P-N junctions, the U-channel tends to become isolated electrically from the P-type regions by two depletion layers shown as clear white.

In these circumstances, when source and drain are connected to an external circuit, current can flow through the isolated N-channel, just as it would through a resistive path. But it is not an ordinary resistive path. If the two P-type regions are joined together and biased progressively more negative with respect to source, the depletion layers will widen



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and gradually reduce the thickness of the N-channel, ultimately depleting it completely of carriers and interrupting current flow.

There is obviously a close parallel between the action of the gate in a FET and grid in a thermionic valve.

For reasons which are fully explained in "Fundamentals of Solid State", the type of FET illustrated in Fig. 1 has output characteristics which resemble those of a pentode valve—fine for RF applications but undesirable for an audio power output device. operating into a reactive load. In addition, the structure cannot easily be modified to cope with high currents, as for a high dissipation device.

The configuration which followed from Professor Nishizawa's work is illustrated in Fig. 2, which we reproduce directly from the material supplied to "Electronics Australia" by Nippon-Gakki (Yamaha). Instead of the current flowing between source and drain parallel to the surface of the chip, it flows at right angles to the main planes, leading to the previously mentioned description "vertical FET" or "V-FET".

As indicated in Fig. 2, the lightly doped N-type drain covers the total area of the chip, allowing heat to be conducted away from it quite freely.

Implanted in the upper surface of the drain is a closely spaced lattice or grid of heavily-doped P-type material which serves as the gate. The layer of N-type material continues through this and above it, to become the source, at the top of the chip.

With this structure, current flowing between source and drain must pass through the holes in the lattice so that, in effect, there are as many channels—and as many parallel connected FETs—as there are spaces in the lattice.

If the lattice (gate) is biased progressively more negative with respect to source, the paths through it will be progressively depleted and narrowed, leading to an ultimate current cut-off. The analogy with a thermionic valve is most obvious.

With this structure, the current density and distribution remains as uniform throughout the chip as the manufacture will allow.

No less important, the very short channels, as compared with the kind of construction in Fig. 1, minimises "pinch-off" as a by-product of the IR drop (see "Fundamentals of Solid State Fig. 8.2") and this produces a family of drain (cf plate) curves very similar to those of the triode power valve.

Fig. 3 further illustrates the structure of a vertical power FET, being an artist's depiction of what would be exposed if a hollow was ground in the top of the chip—through the source contact surface layer, through the source region, through the gate mesh and into the drain region at the deepest point.

Fig. 4 is an actual microphotograph of a chip which has been ground in this way.

Fig. 5 shows a group of Yamaha vertical FETs—looking exactly like any other power transistor. Device information is sparse at this stage but the range would appear to include N-channel FETs as already discussed, their P-channel counterparts and others intended for lower power or voltage amplification. Typically, the power FETs would appear to have an amplification factor (mu) of about 5 with very low output impedance, while the voltage amplifiers have a mu of 50 and, of course, much higher drain impedance.

Vertical FETs produced by other manufacturers differ in structural detail, probably because of patent situations, and individual preferences and facilities. Sony, for example, use an oxide layer for

This Sony model TA-8650 integrated amplifier uses 6 smaller V-FETs (3 + 3 parallel) in a complementary output circuit to produce an output of 80W RMS per channel into 8 ohms. IM distortion and THD at the 1W level is .05% or less at 1000Hz. THD is 0.1% or less at rated output 20Hz to 20kHZ. Response is z0, -2dB from 10Hz to 100kHz.

additional isolation of the gate lattice.

Fig. 6 shows an oscillographic plot of a family of drain curves for a Yamaha power FET. The vertical current scale is 0-10A, the horizontal voltage scale 0-100V, and the plots for gate potentials in 2V steps from zero bias on the left to a maximum of −18V. A cursory examination of the curves in the likely working point zone suggests an amplification factor of 5, a natural output impedance of 5 ohms, and a mutual conductance of 1.25A/V.

Fig. 7 shows drain current (vertical 0-10A) plotted against gate voltage (horizontal 0-20V).

As mentioned earlier, prototype amplifiers using power FET output stages have been shown by a number of Japanese companies. Sony have exhibited advance models in Australia and, by the time this appears in print, FET equipped Yamaha amplifiers should be available.

Preliminary information on a typical Yamaha main amplifier indicates that the output transistors are in a conventional single-ended push-pull configuration, directly coupled to the loudspeaker. The FET drivers are also directly coupled, with a "newly developed biasing method . . . 5 patents pending . . . which permits stable circuit operation even without a stabilised power supply". A triple power supply is used: plus and minus 85V and minus 200V.

The output transistors operate under class-AB conditions but the quiescent current is still high—which is not surprising when it is considered that the output device dissipation is reckoned in hundreds of watts. Even so, the designers have found thermal protection to be quite superfluous. The protection circuitry which is included is there to guard against actual circuit malfunction, and will break the amplifier/speaker connection if a DC potential greater than 2V appears at any time across the voice coil terminals.

Preliminary figures for the amplifier suggest a power output of 150W RMS per channel into 8-ohm loads, over the band 20-20,000Hz, with both channels driven. At the 100W level, distortion at 1kHz is given as 0.01%, and not more than 0.03% at any other frequency within tha abovementioned band. Frequency response is quoted as within +0 to −1dB from 5Hz to 100kHz.

These are impressive figures by any standards, the more so when it is remembered that distortion should diminish with output.

While class-A FET output stages could be scaled for a wide range of power levels, it seems certain that they will come in first at the top end of the market—lots of watts and lots of dollars! But if FET production climbs, as expected, and device costs diminish towards that of comparable bipolar types, the technology will probably spread downward.

Will power FETs revolutionise amplifier design? They probably will, but whether they will revolutionise hifi listening is quite another matter. Good conventional amplifiers probably contribute less to distortion than any other link in the reproduction chain, and the result of improving the already-strongest link may not be all that apparent.

But that doesn't seem to alter the fact that enthusiasts still seem to aspire after the perfect amplifier!

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*"Dolby" is a trade mark of Dolby Laboratories.

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Technics RS-676-US stereo cassette deck

A recent development in stereo cassette decks is the appearance of decks with all controls on the vertical front panel, along with an opening for front-loading of the cassette. An interesting example is the Technics RS-676-US stereo cassette deck, which features solenoid control.

It now seems as though stereo cassette deck buyers are presented with two broad choices: a cassette deck with all major controls and the cassette well on the top surface, or those with all facilities on the front panel and nothing on top.

These latter machines have the advantage that they can be installed behind the front panel of a furniture cabinet together with FM tuner, amplifier and so. The inevitable clutter of connecting wires is right out of sight.

On the Technics RS-676-US, cassettes are frontally loaded by opening the hinged window and placing the cassette on a horizontal platform which is then depressed into the operating position. Pushing the eject button raises the cassette platform and flips the hinged window partially open.

An internal light and a mirror set at 45 degrees makes the cassette visible, provided the viewer has his head at window level. A worthwhile addition would be a light behind the cassette, so that the viewer can judge the progress of the tape. With the present system, there is no way of knowing whether the tape is near end or start, without removing it to look.

Next to the cassette window are the six push-bars for solenoid control of the tape transport. These push-bars have a delightfully light action and a fast response. When the Record, Play or Pause controls are actuated, they are lit up from behind to show the operating mode of the deck.

As on many other decks, the RS-676-US has a memory rewind feature which enables it to return the tape to a preset 'OOO'. But in this case it then goes one better by automatically shifting into Playback mode.

Automatic sensing is provided, for Cr02 cassettes which have the detection recess adjacent to the recording knockouts. Older Cr02 cassettes without the detection recesses are catered for by flipping the Tape Select lever to the appropriate position.

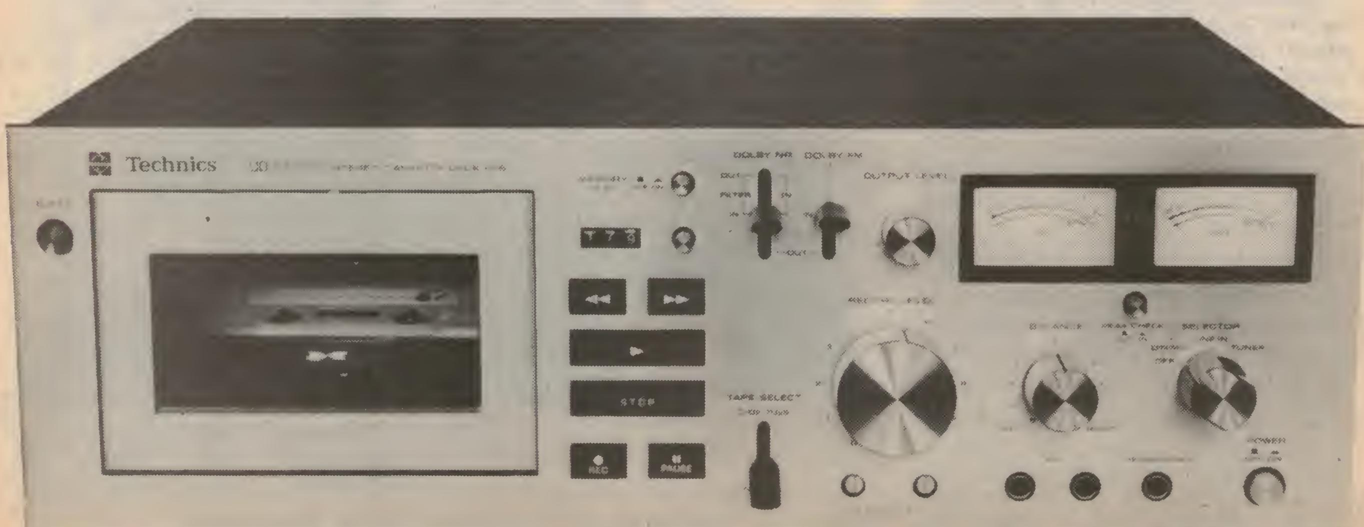
Having the frontal loading system for the cassettes means that the heads are not as accessible as on most conventional decks. When cleaning the heads and capstan you really need a dentist's inspection mirror to do the job properly.

As might be imagined in a machine using solenoid control, the transport mechanism is quite complex, employing at least ten micro-switches, three relays and three solenoids (there may have been a few others hidden away). Two motors are used; one drives the large capstan flywheel while the other drives the cassette spools and the revolution counter. Both motors are DC but the capstan motor is not the direct drive type as used in the RS-276-US (reviewed in "Electronics Australia" November 1973) and the RS-279-US models by Technics.

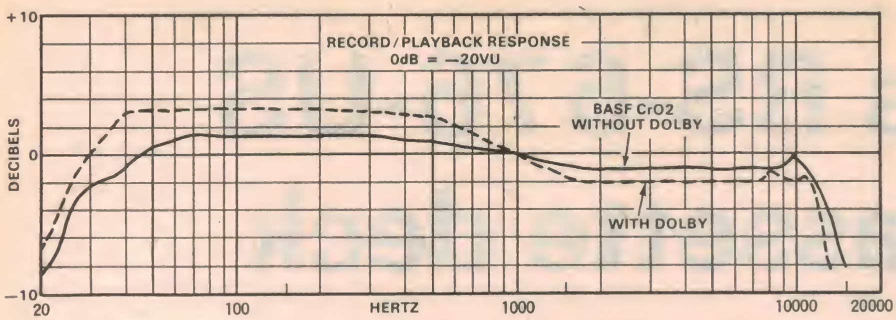
Apart from the solenoids used to control the transport mechanism, there are two large solenoids which operate multi-pole slide switches—for the record function and for the circuit changes necessary for Cr02 tape.

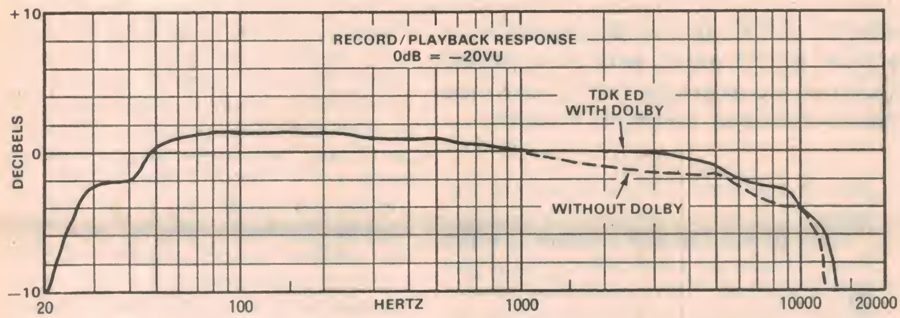
One of the reasons for having relays involved in the control circuitry for the tape transport is that the RS-676-US can be operated by an optional remote control (hand-held), which comes with a long cable connecting to the rear of the unit via a 12-pin plug. This is one of the highly desirable functions that is only made possible by solenoid operation of the transport. Remote control is particularly handy during recording.

A large knob provides control of the recording level together with a Balance



Technics RS-676-US stereo cassette deck





control knob to adjust the relative levels of the two channels. An input selector knob provides a choice of mic, line or tuner inputs.

An interesting feature of the level meters is that they have a push-button which converts them from VU characteristic to peak-reading. When the peak-reading mode is selected, a more accurate response to sharp transients is obtained. As worthwhile as this system is, we are still of the opinion that supplementary LED overload indicators are the final refinement for distortion-free recordings.

Adjacent to the recording level meters is a small knob which controls the output from the Line Out jacks on the rear panel. No level control is provided for the headphone socket.

On models supplied to the USA market, this output knob is apparently replaced by a pair of concentric knobs which, together with the input selector switch, provide mic/line mixing. In our opinion, this facility is more useful than an output level control.

Two 6.5 mm jack sockets are provided on the front panel for low impedance microphones.

Dolby noise reduction is provided as a matter of course, but with a few refinements. When making recordings from FM broadcasts, for example, a filter can be switched in to remove residual 19kHz and 38kHz components from the tuner signal.

This filter is of the very sharp null type so that while it rejects 19kHz tones it does not have any significant effect on the audio bandwidth. Actually the filter has two null circuits, one for 19kHz and one at 38kHz. The latter is always in circuit.

Circuitry is also provided for recording Dolbyised FM broadcasts but this is likely to be of little interest to Australian buyers for some time to come.

Wow and flutter is quoted at less than 0.15% DIN. We measured a best result of 0.2% DIN but we found this depended to quite an extent on the vagaries of the particular cassette used.

Cassette rewind time was quite fast at about 65 seconds for a C-60 tape.

Record/playback response was checked using a variety of tapes, with and without Dolby, and the results are shown in the graphs. As can be seen, there is relatively little loss in highs when Dolby was switched in.

Quite a dramatic improvement in signal to noise ratio was obtained when Dolby was switched in. Typically, the unweighted figure obtained for low noise ferric tape was minus 48dB with respect to OVU and this improved to 53dB with Dolby.

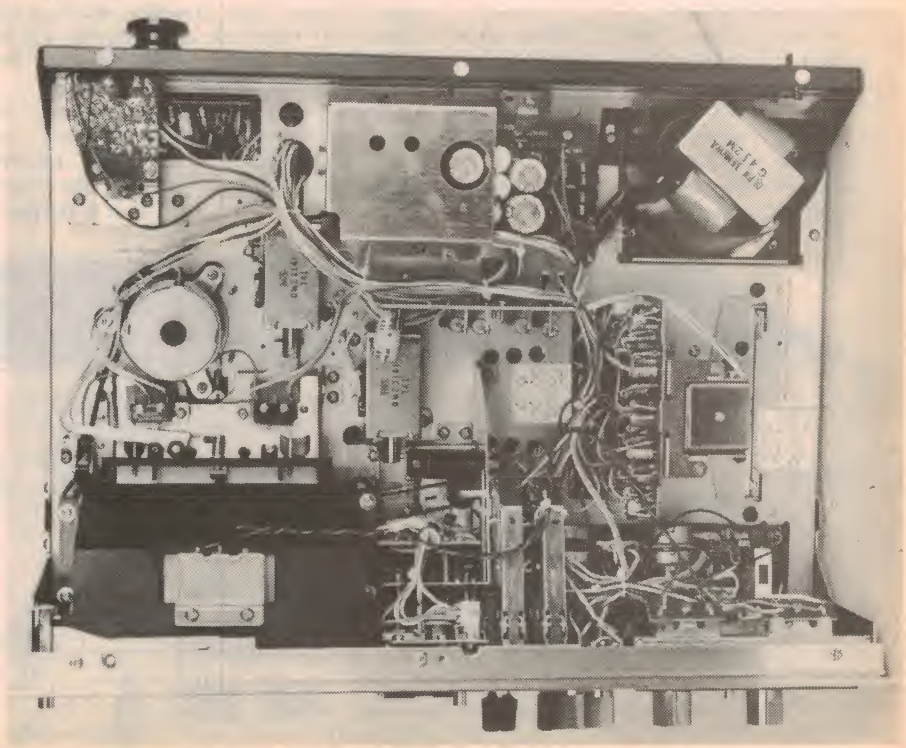
We also made some tests using Ferrichrome tape but found that the bias conditions did not seem to be quite right to get the optimum results.

Radar and RF interference was not noticeable at any time and the reproduction was at all times free of switch clicks and other extraneous noises. Sound quality is excellent and is certainly among the best available from cassette machines.

But clearly, the major attraction of this machine is its operating refinement. Its solenoid control is one of the best we have tested on any deck.

One point though, the unit cannot be stacked on top of other equipment with large transformers — hum increases markedly.

Recommended retail price of the Technics RS-676-US stereo cassette deck is $569.00 including sales tax. For further information on Technics products, contact your high fidelity retailer or the Australian distributors, Haco Distributing Agencies Pty Ltd, 57-69 Anzac Parade, Kensington, NSW 2033. (L.D.S.)



Above is an internal view of the RS-676-US stereo cassette deck.

Kenwood KP-1022 Player System

In spite of the widespread popularity of automatic turntables, there is apparently still a sizable market for manually-controlled units. Some people like them for their simplicity and others for their lower price. For these people, the Kenwood KP-1022 is worthy of consideration.

Like many turntables these days, the Kenwood KP-1022 is marketed as a complete package deal. It is supplied with arm, magnetic cartridge, wooden platform and tinted perspex cover.

From the point of view of some enthusiasts who may wish to build the unit into a furniture cabinet, having to buy the perspex cover as part of the purchase deal will be regarded as a disadvantage. They would still have to buy the timber platform though, because of its suspension system.

Unlike other turntables, the KP-1002 is mounted directly onto its timber base which is provided with four large conical suspension points. While possibly not as attractive, these would appear to provide better acoustic isolation than the suspension on other units.

Measurements of the platform are 350mm (deep) by 445mm (wide). Clearance required at the rear of the unit is approximately 85mm, while the unobstructed height required above the mounting shelf is 435mm.

Three simple controls are provided for operation of the turntable. A toggle lever on the left-hand side selects the speed, either 33 or 45 rpm. On the right-hand side, a lever with a very light action actuates a micro-switch to start or stop the turntable motor. Near the arm pivot is the cueing lever which is damped to provide gentle lifting and lowering of the tone-arm.

Since it is a manually controlled unit, there is no automatic stop or lift-off at the end of a record.

The platter is a 300mm diameter aluminium alloy diecasting driven around an inner rim by the usual flat rubber belt, from a 4-pole synchronous motor with a stepped pulley. The motor windings are connected in parallel or series by a slide-switch for 110VAC or 240VAC operation. This means that there is no power transformer as fitted to some other units, and consequently there is less likelihood of hum induced into the cartridge or pick-up leads.

The chromed tubular arm is S-shaped in the usual manner and is balanced longitudinally by a rotatable counterweight which also provides the vertical tracking force setting. Anti-skating is provided by a hanging weight system which applies force to a calibrated lever on the arm pivot.

A moving magnet cartridge, type V-39 Mk 2, is fitted. It has a 0.5mil conical diamond stylus and a recommended tracking force of 2 grams.

In use, we found the turntable operated smoothly and quietly and is virtually free of rumble, wow and flutter. Kenwood rate wow and flutter at less than 0.07% (WRMS). We measured it at 0.15% weighted according to DIN 45507, which is a good result. The main turntable bearing was quite free. With the belt removed and then spun up to 33 rpm, the platter took 75 seconds to come to a halt.

At right is the Kenwood KP-1022 shown with tinted perspex cover removed.

Vertical tracking forces were found to be within 5% of the calibrated settings and anti-skating settings seemed to be very close to optimum. The arm appeared to have quite low bearing friction in its pivots and would be suitable for cartridges with tracking force recommendations of less than 2 grams.

At the recommended tracking force of 2 grams, the cartridge tracked the plus 16dB band of the W&G 25/2434 test record with no audible distortion, a good result. Cartridge output was 3.4mV at 50mm/sec, which is a little above the specification.

While in some respects the performance specification is fairly exact, the claim for frequency response is vague with a rating of 20Hz to 20kHz and no tolerance quoted. Using a 56k load, we measured the frequency response at plus or minus 3dB between 20Hz and 20kHz. Channel balance was within 1dB over the whole range and separation was an even minus 22dB in both directions and quite symmetrical in both directions.

From the above results, one could judge the cartridge as being a good unit with typical middle-of-the-road performance. But the waveform at frequencies between 4kHz and 10kHz had to be seen to be believed. To say that it was irregular would be an understatement. And no amount of fiddling with the various arm adjustments had more than a slight effect on it.

Sound quality on music signals tended to be harsh and definitely not as pleasant as one expects of a typical magnetic cartridge. As far as the cartridge was concerned, we were not happy. At the very least, one must cast doubts on the quality control of the particular sample tested.

Of course to keep this review in perspective, one must realise that the KP-1022 turntable is a relatively low-priced unit from the Kenwood line.

Since the total cable capacitance in each channel is less than 100 picofarads, it is possible to substitute a cartridge for CD-4 (or UD-4) records.

And we are pleased to note that a three-pin plug and three-core flex was fitted for the mains connection.

In summary, the Kenwood KP-1022 is a well-finished unit with no unnecessary frills. With its mechanical simplicity it should give a lifetime of troublefree service. But if your dealer gives you the option of upgrading to a better cartridge for a few dollars more, we suggest you take it.

Suggested retail price of the Kenwood KP-1002 is $139.00 including sales tax. Further information on the unit can be obtained from hifi retailers or from the Australian distributors for Kenwood, Jacoby, Mitchell & Co Pty Ltd, 215 North Rocks Road, North Rocks, NSW 2151. (L.D.S.)

News Highlights

Video disc contenders prepare for battle

Following the flurry of publicity about two years back, the most conspicuous factor concerning the various forthcoming video disc systems has been the deafening silence from the development companies. In mid-March, however, the three principal contenders in the home video stakes emerged from hibernation to face consumers in Europe and the USA.

Notable among these was the German Telefunken company which began selling its TED mechanical videodisc player in Germany on March 17. Jointly developed by Telefunken and British Decca, the TED video player has been designed in both NTSC and SECAM versions as well as the PAL colour version. However, no US demonstration is scheduled at this date.

In Germany, the TED video player is to be distributed through some 1,000 radio-television dealers and department stores. Retail cost is around the $650 mark—less than half the price of a videotape recorder, according to Telefunken. The TED discs, which offer 10 minutes of colour programs, will retail for about $4 or more, and will include an initial repertoire of 50 titles. It is expected that some 350 titles will be available by the end of the year.

On the same day as the Telefunken release, Philips and MCA were scheduled to start a round of demonstrations in New York of a modified VLP player which can accommodate both rigid (Philips) and flexible (MCA) discs. Philips and MCA recently signed an agreement under which Philips is to manufacture and market the modified VLP player, while MCA will manufacture and market much of the video disc program material.

The agreement is an important one from the Philips viewpoint as MCA has access to a wide variety of entertainment material, including the Universal Pictures film library. In addition, Philips will also gain the rights to MCA's lower cost flexible disc which uses about 1/10 the plastic of the Philips VLP disc, and which can be duplicated on a rotary press. Feature film albums selling through ordinary record shops for about $10 are predicted.

Prime advantage of the Philips/MCA VLP player over the Telefunken TED system is its extended playing time—45 minutes as compared to ten minutes.

The Philips VLP player—a serious contender in the home video stakes.

Signal pick-up in the VLP player is by means of a laser beam which scans information encoded into spiral tracks on a reflective metallised disc. For a more detailed technical description of the VLP player, readers are referred to the November 1973 issue of "Electronics Australia."

The Philips/MCA deal effectively narrows the video disc competition in the US to two systems, the other being the RCA capacitive pickup system known as "SelectaVision." Details of the RCA system were released towards the end of February when the company announced plans to set up a permanent "SelectaVision VideoDisc" demonstration in New York about the end of March. Previously, the RCA system had been demonstrated only to other manufacturers in order to attract licensees.

The RCA capacitative video system is similar in many respects to a conventional record player. Program storage is on metallised discs, and takes the form of a series of transverse slots of varying width and separation etched into a precut groove by an electron-beam recording system. The discs are two-sided and provide a total playing time of some 60 minutes.

Signal pick-up is by means of a sapphire stylus containing a thin metal electrode. This stylus rides in the groove, the electrode detecting the relief pattern by changes in the capacitance between its tip and the metallic coating on the record surface.

As with RCA, Philips and MCA are currently courting licensees, especially Zenith in the US and Thompson-CSF in France. Most of Zenith's work has been in the optical disc area, its prime system being essentially an NTSC version of the transmissive system developed by Thomson-CSF. Observers believe that both companies will move into the Philips/MCA camp if agreement can be reached on standardised software for use in both reflective and transmissive optical systems.

However, Zenith has also been working on an electrostatic-capacitance disc pick-up system similar in principle to the RCA system. At this stage, then, Zenith must be listed as uncommitted, but leaning strongly towards the optical system.

Giant Japanese manufacturer Matsushita is being wooed ardently by both camps. Probably the world's largest TV maker, it provides the key to the Japanese market and must be considered a major factor in the US battleground. As Matsushita goes, so go Panasonic, Quasar and JVC.

(continued on page 25)

500W CO_2 laser will cut aircraft parts

Advanced composite materials used in the production of aircraft parts are to be cut by laser techniques under a contract announced recently by the Hughes Aircraft Company. The contract, worth about $750,000, was awarded to the Hughes Aircraft Company by McDonnell Douglas, and calls for the development of a numerically controlled laser cutter for delivery by the end of the year.

Hughes laser-cutters have already found wide application in the garment industry and the shoe industry, where they are used for cutting out patterns. McDonnell Douglas says that the new system will be similar to the models used in the abovementioned industries in that it will use a small computer to store cutting information, a linear motor positioning system, and a high powered laser. The laser itself will be a 500W carbon dioxide model.

The new laser cutter will be used in the production of aircraft parts which are subject to high stress factors. These often contain boron fibre and carbon fibre reinforcement, and are hard to machine satisfactorily using conventional methods. The laser system should therefore offer considerable advantages over the old methods, both in terms of speed and cost. Waste of expensive material should also be considerably reduced, and cutting accuracy improved.

Video disc contenders prepare for battle . . . ctd

Politically, Matsushita has good reason to go either way, having joint bonds with both Philips and RCA. On the Philips side of the ledger is its joint ventures with Matsushita in Japan (involving the manufacture of semiconductors and picture tubes) and in Europe (batteries). Counter to this is Matsushita's alliance with RCA in promoting the CD-4 quadraphonic sound system.

RCA's main advantage at this stage is the fact that it is probably some 12 months ahead of the Philips/MCA group, and the RCA strategy is now geared to speed. In addition, the SelectaVision system uses relatively conventional components compared to the VLP player which requires the production of laser signal pick-up units and specialised servo systems. RCA feels that this factor will place the company in a favourable position as regards cost, although admittedly their system is less versatile than the Philips/MCA VLP system.

What this means in terms of marketing dates is difficult to forecast at this time. What it does mean is that the Australian consumer is unlikely to see a video disc system here for at least two years—unless a decision is made to market the Telefunken-Decca TED system.

Flat screen video communications system

An experimental flat-screen video system that transmits handwriting, reproduces pictures, and can be used to communicate directly with a computer has been demonstrated by scientists at Bell Telephone Laboratories, Holmdel, New Jersey.

The system consists of a commercially available plasma panel display (modified by Bell scientists), electronic control circuitry, and a special pen called a light pen. Plasma panels are made up of thousands of tiny neon-gas cells arranged in vertical and horizontal rows. These cells glow when energised by an electric current.

In the Bell Labs' system these cells are selectively turned on or off to produce an image. Message transcription is effected by means of a light pen which acts as a pencil or pointer. Images placed on a sending panel by this means can be transmitted to a distant receiving panel over telephone lines.

A unique part of the Bell Labs' development is the method used to achieve the grey tones necessary for picture or facsimile reproduction. Gradation in tone is obtained simply by altering the density of cells turned on over a given area of the panel.

Atomic plants may burn radioactive wastes

A nuclear fission energy system, capable of eliminating a significant amount of its radioactive wastes by burning them, shows considerable promise, scientists and engineers from NASA report.

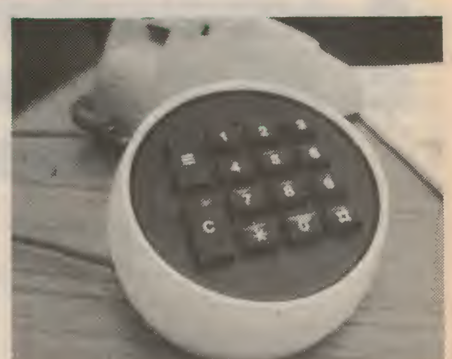
A study of the system, a theoretical investigation conducted by computer analysis, is based on use of gaseous fuel nuclear reactors. Gaseous core reactors using a uranium plasma fuel have been under study and development for space propulsion by NASA for several years.

A major atomic energy headache in recent years has been the various long-lived high-level radioactive wastes produced in the fission process. Some of these wastes have a half-life of many thousands of years. One solution to this problem may be to transform such radioactive wastes into harmless materials by bombarding them with neutrons.

The unique characteristics of gaseous fuel reactors make them especially suited to burn up nuclear waste materials, as these reactors have a large neutron population. The fuel, a gaseous compound of uranium, can be readily circulated and returned to the reactor to burn up radioactive materials produced in the fuel.

Computer analysis showed that a gaseous fuel reactor, after three years of operation, can establish a balance in rates of production and elimination of these waste products. Once this equilibrium has been established, no additional long-lived radioactive wastes will be produced.

Post Office approves push-button dialler



The Australian Post Office has approved a new telephone number dialling device that provides push-button dialling. Designated the SpheriCall, the new device is to be marketed in Australia by Philips TMC Ltd.

SpheriCall is based on the latest MOS-LSI technology and adds the speed and convenience of press-button dialling to an ordinary rotary dial telephone. It features a "try again" facility at the press of a button, and a memory in which the 10 most frequently used numbers (up to 18 digits long) can be stored. Any of these numbers can then be called automatically simply by pressing the appropriate button.

The unit is used with a normal telephone, and requires no internal modifications to existing telephone equipment. It's expected to win widespread acceptance in Australian business commerce, and even in private homes.

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NEWS HIGHLIGHTS

New scientific calculator range

Novus, the Consumer Products Division of National Semiconductor Corporation, has introduced 14 new calulators in the USA to form the broadest range of portable calculating power available from a single manufacturer.

The new calculator range, unveiled at the Winter Consumer Electronics Show in Chicago, included five personal calculators for general consumer and business uses, five advanced calculators dedicated to a variety of professional computation tasks, and four 100-step "learn mode" programmable calculators.

The new Novus models have been introduced progressively into Australia over the past few months commencing with the model 850 and model 4510. The model 850 is an 8 digit floating decimal point machine with algebraic logic retailing at $19.95. This joins the existing Novus 650, 950, 820 and 823 at the consumer end of the market.

The model 4510 Mathematician was the first of the Novus "Professional" models to be introduced. It is an electronic slide rule featuring RPN logic, a 3 level stack, separate accumulating memory and a full range of arithmetic, trigonometric and logarithmic functions, square root, reciprocals etc. The 4510 retails for $79.95.

Following the model 4510 Mathematician, several additional dedicated professional models including the 4520 Scientist, 6010 International Computer, 6020 Financier and 6030 Statistician were introduced. These models are preprogrammed to provide the functions and formulae their names imply. The prices of these models will range from around $100 for standard versions to $179.95 for 100 step keyboard programmable versions.

For further information contact Novus, NS Electronics Pty Ltd, Cnr Stud Rd & Mountain Hwy, Bayswater, Victoria 3153.

New Manpack radio for US Marine Corp

A new, virtually-automatic Manpack radio that provides the use of 280,000 high-frequency-band channels to communicate over distances of hundreds of miles is being produced by Hughes Aircraft Company. Known officially as the AN/PRC-104, the new unit is designed to lighten the burden of a combat radioman, and to provide the highest degree of flexibility in tactical communications.

Hughes' ground systems group in Fullerton, California, will build about 5,000 of the new radios for the US Marine Corps under a $22 million contract recently awarded by the US Naval Electronics Systems Command, according to Sam A. Stameson, Communications and Radar Division Manager.

The radio has so many automatic features that it is virtually a "hands-off" set. "The radioman simply goes into the transmit-receive mode, selects his frequency, and hits the press-to-talk switch. The antenna is tuned, the set is aligned, and the transmitter comes up full power, all automatically," Mr Stameson said.

Hughes' Manpack project manager Donald Q. Hall said the PRC-104 employs advanced circuit design and micro-miniaturised solid state devices to achieve high performance and ruggedness in an extremely small package. The radio, with its battery, forms a package only 12½ inches wide, 11½ inches tall and 2⅝ inches thick. Each unit weighs only 12½ pounds, including the battery pack.

Output power of the AN/PRC-104 transceiver is 20 watts, whilst average power consumption is somewhat less than five watts. Typical operational conditions call for a range of 50-300 miles.

—George E. Toles.

Solar cells: the promise of sunshine electricity

Spurred on by the realisation that the world supply of fossil fuel is limited and that it will continue to rise in price, the pace of solar energy research in the United States is beginning to quicken. Much of this research is aimed at producing low cost solar cells for converting sunlight directly into electricity. This article takes a brief look at solar energy research in the United States, and presents a timetable for the future.

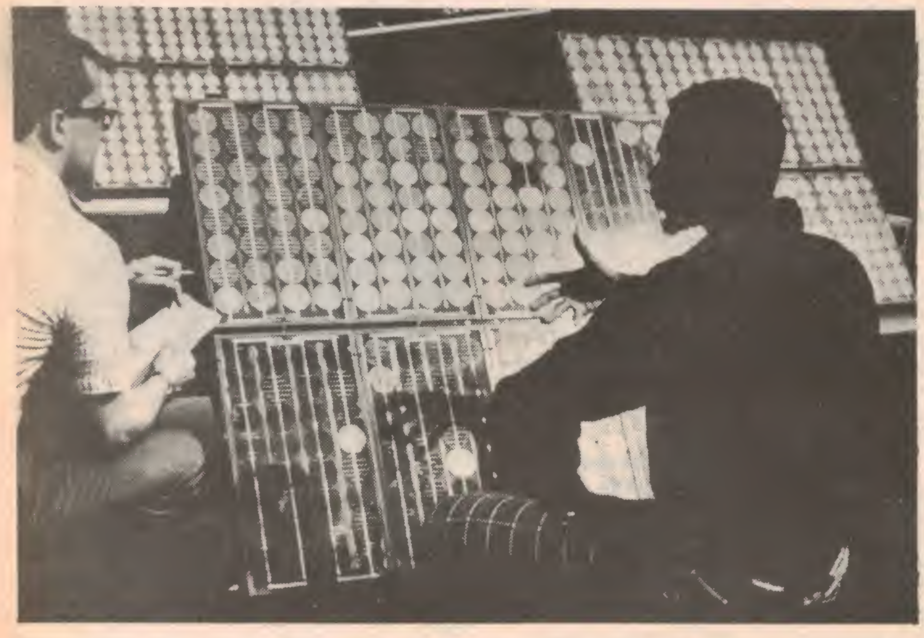
by JOHN R. FREE

Sunlight glistened from thousands of solar cells on a rooftop near Washington, DC. I was looking at the most powerful solar cell array assembled for terrestrial use in the world. But its 1000-watt power rating seemed modest for this claim. Mitre Corporation, an engineering firm studying solar cell systems, had paid $30,000 for 20 panels of cells.

That's $30 a watt, typical for solar-cell power today, and the main reason larger arrays aren't delivering tens of kilowatts or megawatts to homes and buildings. Costs quickly become astronomical. What's kept solar cell prices so high over the years has been technological limitations and a small, specialized market. Solar cells, priced at $200 to $600 a watt, have been used primarily in space vehicles and satellites, where they must be used regardless of price.

Reprinted from "Popular Science", by arrangement.

But now, with energy scarcities becoming critical, there's a growing effort to reduce solar-cell costs and bring cell power down to earth. Industry, government, and academic experts I've visited and questioned are optimistic that manufacturing costs for cells can be shaved to fifty, then thirty cents a watt during the 1980s. At these prices, cell systems for homes, schools, shopping centres, industrial plants, and utility power networks are practical.



These glittering solar cell panels each produce 50 watts of peak power. Twenty such panels, mounted on top of the Mitre Corporation building in Washington DC, are used by Mitre Corporation as the basis for an experimental 1kW system.

One irrefutable fact makes Joseph Lindmayer of Solarex Corporation hopeful: silicon—now used for most solar cells—is the second most abundant element on earth next to oxygen. (Sand is mostly silicon dioxide.) "Between the abundant resources of silicon and light," Lindmayer told a US Senate subcommittee, "we have only technological difficulties in making the systems work economically."

Happily, a string of developments suggest these difficulties can be solved:

- A breakthrough process called edge-defined film-fed growth (EFG) promises low-cost cells made from continuous silicon ribbons;
- Oil companies are pumping vital funds into EFG development and the improvement of cadmium-sulphide (CdS) solar cells;
- Spinoffs from space research are boosting cell efficiencies and suggesting ways to automate production;
- Manufacturers of purified silicon are exploring ways to trim raw-material costs;
- Systems to store solar energy for round-the-clock use are being designed and tested; and
- Techniques are being studied to boost solar-cell power enormously by concentrating sunlight.

Quickening the pace of solar energy research is the realization that our supply of fossil fuels is limited and that they will continue to climb in price. As a result, the US Government is planning a billion-dollar effort to tap the sun's energy. "It appears possible that by the year 2000, solar-energy systems might be capable of supplying 5 to 10 percent of the total US electricity requirement," says John Sawhill of the Federal Energy Office.

Numerous efforts are underway to use solar energy: solar heat-to-electricity power plants; wind power created by solar heating; solar heated/cooled homes and buildings; and even generators powered by differences in ocean temperatures. Researchers are also studying chemical processors to convert solar energy stored in vegetation into fuels.

The power source for all these approaches is free and inexhaustible by human time scales. In the US, the Sun beams a daily, all-weather average of 194 watts on each square metre of land. Ordinarily, each day, the roof of your house

receives three times more energy from sunlight than the energy you consume by heating, cooling, or other electrical usage.

But solar cells have a special advantage. Using what is called the photovoltaic effect, they convert light directly into electricity. There is no physical movement involved, no heat-to-steam step, no air pollution and no noise.

Cells, of course, have disadvantages, too. Like other solar energy systems, their dependence on sunlight mandates an energy storage system, such as batteries. Efficiency of solar cells (input versus output power) may be limited to about 23 percent. And for widespread use, the DC output of cells must be converted to AC.

Also, a large land area is needed: one square mile of 12-percent-efficient cells delivers an average of 50MW power. (Cells are rated for their peak output—when the sun is brightest. Average power, figured over 24 hours, is about one-fifth peak power.) Right now, though, the biggest obstacle to solar cell systems is cost.

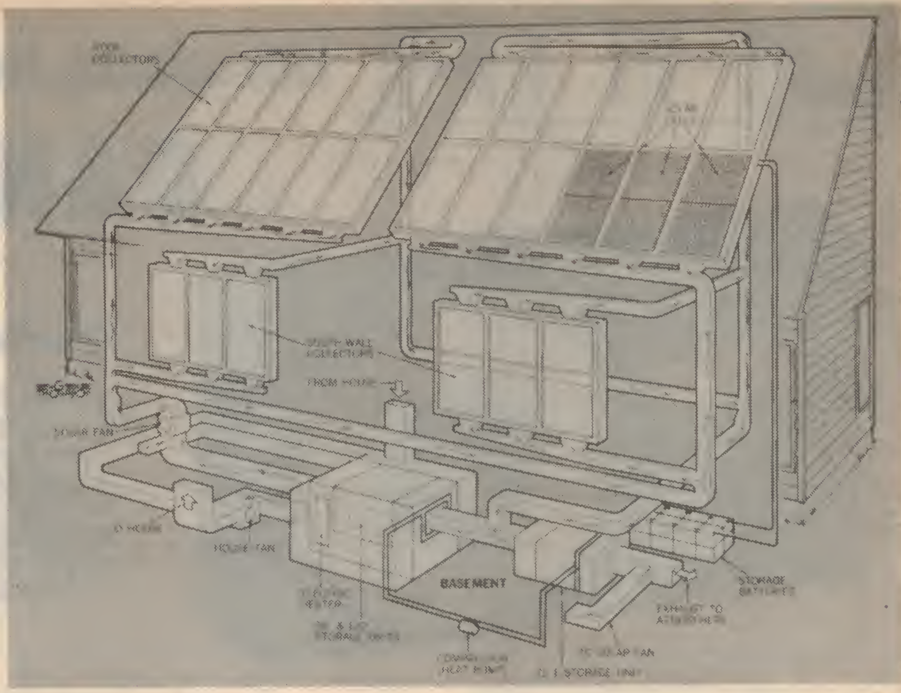
The manufacturing process used today is primarily responsible for the high price of silicon cells. Solar cells were developed at Bell Labs during the early 1950s. Researchers found that to make efficient cells, the jumbled polycrystalline structure of purified silicon must first be converted into the orderly, all-in-a-line structure of single-crystal silicon. They turned to the Czochralski process.

This crystal-growing technique, invented in 1923, provides single-crystal silicon in the form of cylindrical ingots two or more inches in diameter. Producing these ingots, however, is time-consuming and costly. One batch of silicon must be melted for each ingot. A pinch of boron, phosphorus, or another impurity converts the purified silicon (a poor electrical conductor) into a semiconductor.

Then, a silicon seed crystal is lowered into the 1,420°C liquid and an ingot is "grown" by twirling and pulling the seed upward at a few centimetres per hour.

But, once an ingot has been painstakingly grown, up to three-quarters of it must be destroyed to produce solar cells. During a tour of NASA's extensive research facilities at the Cleveland Research Center, I saw why. A circular diamond saw, which looks much like its cousin at your meat counter, zips slices from icicle-like silicon ingots as easily as it would cut through butter. The silicon slices are only 0.25-0.30mm thick. But since the saw blade is also this thick, much of the ingot becomes sawdust. Rectangular cells, used for compactness in space, waste still more silicon.

Grinding and polishing these silicon wafers pushes labour costs higher. Wafers are then baked in a chemical atmosphere that diffuses another semiconducting layer into one surface. Finally, electrical terminals are attached and the wafers are wired into solar panels.



Solar One house at the University of Delaware "harvests" sunlight into both heat and electricity, and will ultimately obtain 80 percent of its energy needs from the Sun. The 45° angled roof has 24 solar panels, three of which are covered with cadmium-sulphide (CdS) solar cells. Six additional panels are on the south wall. DC electricity generated by the solar cells is used to charge an 18kW/hr battery system for lighting and resistive type appliances. A DC to AC inverter is planned for motor-driven devices. Heat energy generated in the cells is collected by air circulating beneath the cells. This hot air passes through ductwork into a basement storage system using eutectic salt bins. The heating cycle is supplemented by a heat pump which can also be used to collect cool air at night, further chilling it to freeze another eutectic salt for the air-conditioning system.

Automating some steps should bring costs down to $5 a watt with Czochralski ingots in a few years. That's still too expensive for large scale applications, but reduced prices would increase solar cell use.

Solar cell costs can be effectively trimmed another way. At Solar Power's small plant near Boston, president Bob Willis demonstrated how a cell's power can be boosted several times—or hundreds of times. Standing on a roof, I saw several test cells covered with dome-shaped plastic lenses. By concentrating sunlight on a cell, Willis explained, its current output can be increased in proportion to the light collected. Most manufacturers are also experimenting with mirror concentrators and thin Fresnel plastic lenses.

Sunlight concentrators look like a promising way of reducing costs (fewer cells are needed), but there are tradeoffs. "One advantage of solar cells is that you don't have to do anything to them," says Dan Bernatowicz, who directs solar research at NASA's Lewis Center. "They just sit there and generate power for years and years."

This advantage of unattended, long-lived operation could be lost if large concentrators are used, Bernatowicz feels. The reason: exotic devices needed to remove excess heat from cells may break down. Similarly, mechanisms for tracking the sun throughout the day could fail. Bernatowicz thinks seasonal tracking (periodically shifting cell panels by hand) might be more practical.

The role that concentrators or tracking mechanisms might play in large-scale systems is undetermined. But most experts believe the key to cost cutting lies in the cell-manufacturing process itself. And now there's a process called edge-defined film-fed growth (EFG) that appears to offer great promise.

EFG, which provides long ribbons of single-crystal silicon, resulted from a joint venture by Tyco Laboratories and Harvard University. Mobil Oil Corporation recently agreed to provide up to $30 million to develop EFG jointly with Tyco over several years.

Originally, EFG was developed to speed the growth of single-crystal sapphire, used for microcircuits and in other industrial applications. When a die is lowered into molten silicon or sapphire material, the liquid rises through its centre by capillary action. The material flows only to the top edge of the die whose shape determines whether a tube, square, ribbon, etc., is formed. A seed crystal pulls the solidifying material upward; one thin dimension must exist to

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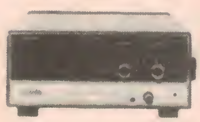

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enable heat to dissipate quickly. In contrast, thick Czochralski-grown ingots lose heat slowly and take much longer to crystallize.

What makes Mobil bullish on EFG is the phenomenal rate at which silicon can be produced. This year Tyco pulled a six-foot-long ribbon from a crucible of molten silicon in one hour. The ribbons can be converted into solar cells without costly grinding and polishing.

"The next major step is to produce a ribbon 50 to 100 feet long," says Tyco's A. I. Mlavsky. That step, which Mlavsky believes will occur before mid-1975, will be a significant EFG milestone.

Standing near one of Tyco's single-ribbon EFG lab machines, however, I found the numbers involved in this engineering scaleup to be staggering. According to one estimate, to produce 4000 MW (about one percent of US generating capacity today), would require 80 square miles of 12-percent-efficient solar cells and about 100,000 tons of silicon. That translates into 40,000 ribbons growing simultaneously for one year, according to Motorola's I. A. Lesk.

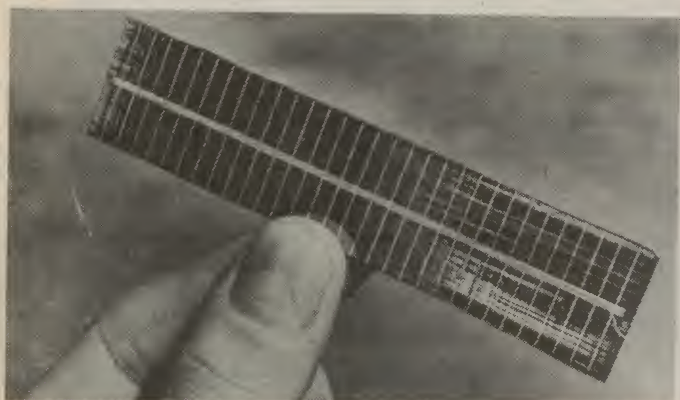
Another ribbon process, called dendritic-web growth, was developed during the 1960's at Westinghouse. In this technique, wire-like seed crystals, which act as ribbon edge supports, are used to pull silicon from the melt. "It's like a couple of wires with a bridge across the top being immersed in a soap solution," says Raymond Seidensticker of Westinghouse. Although web-process ribbons were being wound on spools years ago, most authorities believe the process isn't economical enough for mass production.

Some researchers are trying to form extraordinarily thin films of silicon—millionths of an inch thick. Although thin-film polycrystalline cells would be cheap compared with single-crystal forms, the efficiency hangup must be solved. So far, polycrystalline efficiency has been limited to about one percent. Without improvement, such arrays would require enormous land or rooftop areas.

A wide variety of alternatives to junction-type silicon cells are being investigated, too. IBM recently brewed up an 18-percent-efficient gallium-arsenide cell. Gallium is nearly as abundant as lead. Schottky-barrier devices—thin semi-conducting layers with an ultra-thin metal coating—are also showing promise.

Next to silicon-based cells, however, the most intensely studied devices involve thin films of cadmium sulphide combined with copper sulphide and other compounds. Solar Energy Systems, associated with the University of Delaware's Institute of Energy Conversion, is setting up lines to fabricate cadmium-sulphide (CdS) cells with $3 million backing by Shell Oil Corporation.

Although CdS cells are less expensive and simpler to manufacture than silicon cells, they have several disadvantages by comparison. Their efficiency has been limited to less than eight percent, and they deteriorate rapidly when exposed to air.



Developed by Tyco Laboratories, this experimental solar cell is made from silicon ribbon grown by the EFG process.

Nevertheless, carefully encapsulated CdS cells have been used to collect data from Solar One, the solar home built by the Institute. So far, only three CdS panels have been installed on Solar One. The use of NASA reject cells has also limited overall efficiency to 2.5 percent (340 watts peak).

According to physicist Karl Böer, data gathered during two winter and spring days shows that a completed CdS roof panel would provide from 26 to 43 percent of the home's electrical needs. The eight-percent cells Böer anticipates from Solar Energy Systems could supply some 87 percent of Solar One's requirements.

Mitre is also collecting data from its 1kW system, and is designing a 1MW system. Part of the electricity generated by the 20 rooftop panels will produce hydrogen and oxygen from water; fuel cells will help provide power when the sun is not shining.

Results from these and other working systems—combined with low-cost cells developed in coming years—will provide the technology to conserve billions of dollars' worth of fossil fuels.

Timetable leading to large-scale terrestrial applications of solar cells

1975 Data-collection network established to measure sun's intensity throughout U.S.

1976 Solar arrays tested at several sites. Central-station cost limits determined.

1977 Lower-power systems designed. Technology for $5/watt (peak) cells attained.

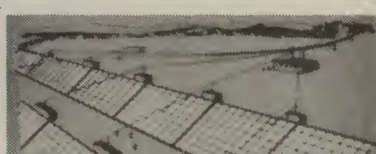
1979 Low-power system installed. Technology shown for $0.50/watt (peak) cells.

1981 Pilot line completed to manufacture arrays using $0.50/watt (peak) cells.

1982 Solar-cell systems from 10 kw to 1 Mw installed in homes, schools, etc.

1985 Medium-power 10-Mw systems built for communities and large industrial plants.

1986 Pilot-line completed to manufacture $0.30/watt (peak) solar-cell arrays.



1990 Giant solar-cell systems (100 Mw or more) provide power to towns and utilities.

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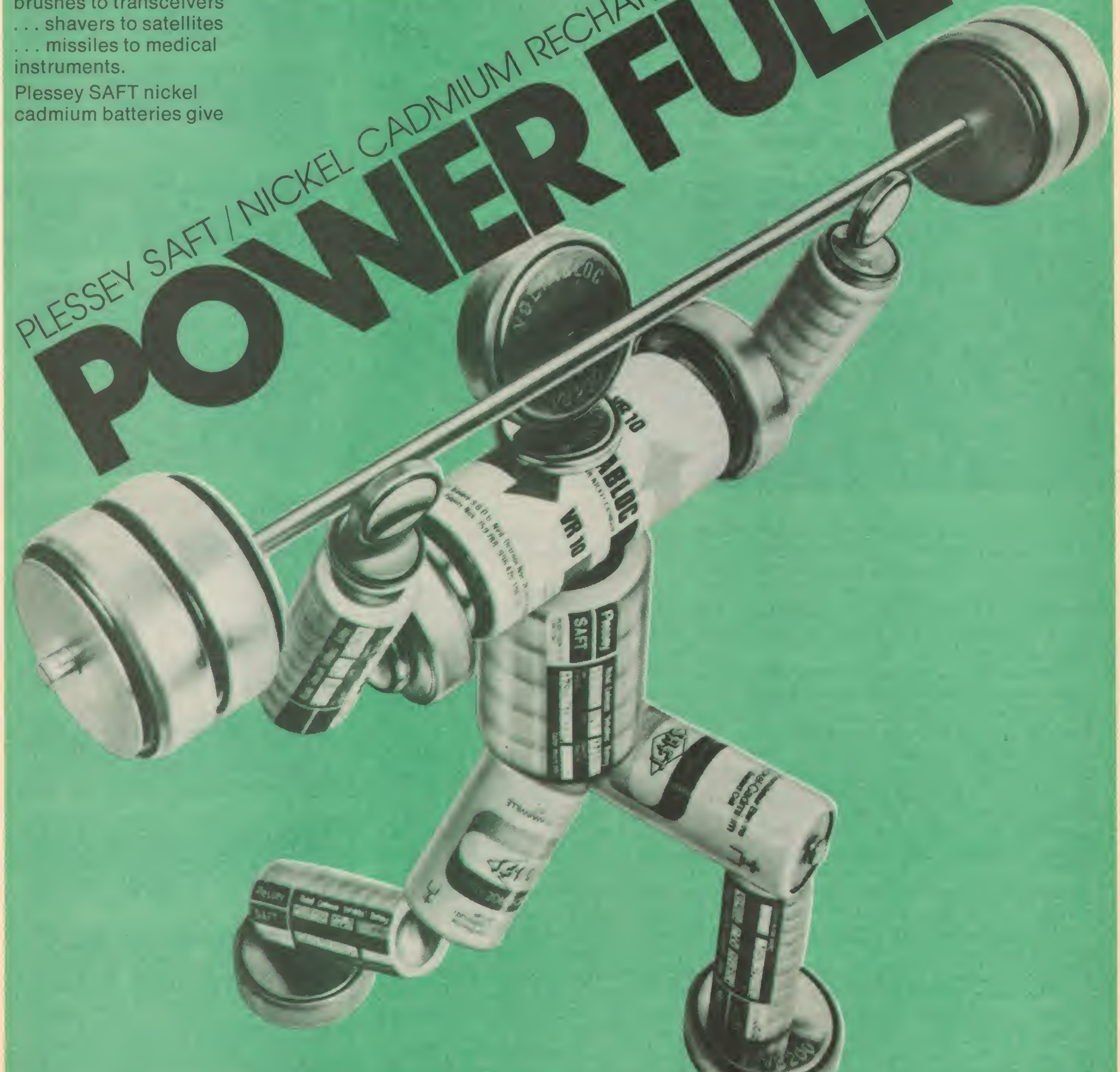

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AC 37/R1 HOLT

Frequency calibration using a colour TV set

Numerous occasions arise when it is desired to calibrate an oscillator against an accurate frequency reference. Most Americans have such a reference sitting in their lounge room—the colour TV set. The US National Bureau of Standards has devised several methods for calibrating an oscillator against the 3.58MHz colour burst signal as transmitted by the four major networks.

Researchers at the Boulder laboratories of the National Bureau of Standards have developed a series of techniques which use network television signals to calibrate oscillators with accuracies approaching a part in 10^{11}, in 15 minutes or less of measurement time.

This combination of speed and accuracy exceeds that of any other system of frequency calibration available today and accomplishes it at relatively low cost. For example, short wave radio broadcasts can achieve only 1 x 10^{-7} accuracy (a part in 10^{7}) if propagation conditions are favourable, and low frequency broadcasts can provide 1 x 10^{-10} only after one day of averaging or 1 x 10^{-11} in a week of averaging. Such long averaging times for high accuracy are obviously inconvenient and, when the oscillator under test has a drift rate exceeding a part in 10^{10} per day, they become useless.

The new techniques permit anyone with a colour TV set to "borrow" the networks' atomic frequency standards for his test. All four major networks in the USA (ABC, CBS, NBC and PBS) use rubidium-controlled oscillators to create the 3.58MHz frequency that forms the colour burst signal. This stable signal is present in all network-originated colour programs, and when a TV set is tuned to a live network program (not delayed on tape by the local station), the TV set's circuit is locked to this frequency.

NBS measures the networks' frequencies regularly and publishes their relationship to the NBS standard frequency. Thus, a user can calibrate his own oscillator in terms of the NBS standard by using TV.

There are several ways to extract this frequency from the TV receiver and use it to calibrate another oscillator. In order of increasing complexity, four techniques developed at NBS are: the "RF Colour Bar Comparator," "Video Colour Bar Comparator," "Digital Subcarrier Comparator" and "Digital Offset Computer."

The "RF Colour Bar" technique requires no modification to the TV set and achieves 1 x 10^{9} accuracy in less than 5 minutes of measurement. For a parts cost of less than $50, a small electronic circuit can be built which creates a vertical rainbow coloured bar on the TV screen when attached to the antenna terminals. When the oscillator under test is plugged into the circuit, the bar moves across the screen at a rate proportional to the difference between the tested frequency and the network frequency. When the difference is small, the motion is very slow, and the bar changes colours at a rate proportional to the difference. The test oscillator must have a frequency of (5/N) MHz when N = 1,2,3,. . . By timing the number of seconds required for the colours to change from red through blue, green and back to red, the difference between frequencies can be calculated.

A typical readout obtained using the digital offset computer technique. The current 10 samples of frequency difference are displayed in the left hand column, while the averages of 10 groups of 10 samples each are displayed in the right.

The "Video Colour Bar" technique is very similar, except that the colour calibration signal is injected into the chroma circuit instead of the antenna terminal. This requires the addition of a resistor and two capacitors to the TV circuit, but does not interfere at all with normal program reception. The advantage is an improvement in the appearance of the colour bar, which improves the resolution of the measurement. This version permits 1 x 10^{10} accuracy in 5 minutes.

The third version requires more elaborate circuitry and provides greater accuracy. Called the "Digital Subcarrier Comparator," it generates a narrow vertical line that proceeds slowly across the screen and then snaps back rapidly, acting as an analog indicator of the phase difference between the frequency being tested (or adjusted) and the reference signal from the network. At the same time, the period of one cycle of this phase difference is indicated by a 4-digit counter. Accuracy to one part in 10^{10} is possible in 1½ minutes of measurement time, or 2 parts in 10^{11} in about 15 minutes.

The most accurate and easiest-to-run is the fourth technique which is almost completely automatic. The circuits developed by NBS take a series of averaged readings, automatically compute the difference between test oscillator and reference signal and display the difference in 10 four-digit numbers on the TV screen. The numbers are averaged by the operator to obtain an accuracy approaching one part in 10^{11} in 15 minutes.

Reprinted from "Dimensions", by arrangement with the US National Bureau of Standards.

A control unit for intermittent wiper action

In this article we present full constructional details of a simple type of intermittent windscreen wiper control, which uses a minimum of parts, and can be fitted to almost all types of cars. Fitted with push button control, our Variable Delay Wiper will make a neat addition to your dashboard.

by DAVID EDWARDS

Almost anyone who drives a car must have found themselves in the situation where it is raining hard enough to need to use the windscreen wipers, but not hard enough to need them on continuously. As a result, one has to constantly reach for the wiper switch, turning them on and off as the need arises. This can be very tiring on a long trip, and must reduce the driver's concentration, so vital to a safe journey.

Two-speed wipers do help to alleviate this problem, but do not entirely cope with all weather situations, particularly when it is only just raining, and a wipe every few seconds or so is all that is needed. The Variable Delay Wiper control described in this article is designed to overcome this problem, in a simple, reliable and economical way.

One of the main features we have incorporated into the controller is that it should fit all makes of cars without modifications, yet at the same time be simple to build and operate. In its basic form, our controller is suitable for both positive and negative earth cars, for single and dual speed wipers, and for wound field and permanent magnet motors, including those with dynamic braking.

The second major feature we have incorporated into our design is inherent safety. When the controller is not being used, the wipers are controlled by the main wiper switch, exactly as standard. To use the Variable Delay Wiper, the main wiper switch is turned off, and the Variable Delay Wiper turned on. If during intermittent operation, it is required to use the wipers normally, operation of the main wiper switch will achieve this.

As presented in this article, the controller is only suitable for use with 12V cars. However, only one component (the relay) need be changed to enable use with 6V vehicles. This controller cannot be used in cars which are already fitted with continuously variable wipers. (These cars probably have a completely satisfactory system anyway!)

In order to make the controller applicable to all cars, we have not used a completely solid state design, but incorporated a relay as the output device. This serves four purposes: it functions as a power amplifier; it provides isolation between the electronics of the controller and the wiper circuitry; it makes possible the control of most types of wipers; and it ensures that normal operation of the wipers will be possible in the event of a failure of the controller.

The completed prototype, housed in a plastic case.

This last feature arises because the relay, in the unoperated position, does not alter the original circuitry of the main wiper control switch in any way, so that if a failure does occur, the circuitry will not be changed. If the failure is such that the relay remains energised, it is only necessary to turn off the Variable Delay Wiper to de-energise the relay.

There is of course a possibility that the relay could mechanically jam in the operated position, but the chances of this occurring should be very remote.

The conventional way of varying the delay rate of the wipers is via a potentiometer, in the same way as the volume of a radio is varied. However, we have found that this does not give satisfactory control, due to the nature of the effect being controlled.

When the volume control of a radio is varied, the change in level of the sound is detected by the ears, processed by the brain, and applied to the hands controlling the volume. This is a stable system, as any tendency for a too drastic change is immediately perceived and acted on. Of course, this requires a little practice, but this is usually easily mastered.

This system achieves stability because of the speed with which the brain can act on the information that the change is too large, and use it to control the hand. Unfortunately, there is a time delay inherent in the use of this system to control our variable delay wipers, and we can no longer achieve stable operation.

This delay arises because we are trying to control a delay. Suppose that our control is set to give a ten-second delay between wipes, and it has just finished a wipe. The next wipe is not due to commence for about ten seconds, but we decide to increase the wiping rate to one every five seconds. If we give the control pot a nudge in the correct direction, nothing happens, at least not immediately. There is no signal to tell our brain what the effect of the nudge was.

Figuratively speaking, we are floundering in the dark, so to get some sort of response, we give the pot a much larger nudge. This produces a wipe almost immediately, but we then discover that we have increased the wiping rate to one every two seconds. This was not the intended effect.

In trying to set the wipe rate back to one every five seconds, we again are floundering in the dark, and so must resort to a process of trial and error. This of course, must detract considerably from our driving concentration, leading to an increase in the risk of an accident.

This problem can be overcome by providing a calibrated scale, but this is not without disadvantages, as it is now necessary to look at the control whilst operating it. This must again necessarily reduce the driver's concentration on his immediate task.

Our solution is based on the premise that it is not necessary to have an infinite number of delays, but only say three or four, and to make these selectable by means of a switch. By making this switch simple to operate, we would introduce a minimum interruption to the driver. A further feature that we felt would be desirable to incorporate is an "instant wipe" facility, enabling the delay to be interrupted to give a single wipe.

The type of switch we chose was one of the "Isostat" push button range marketed by McMurdo Pty Ltd. These are available in a wide range of styles and configurations, and we found it possible to design a composite switch to suit our particular needs.

We have used a five switch assembly, with 20mm spacing between segments. This spacing, in conjunction with the small round knobs we have specified, means that operation of the switch should be quite simple, even for relatively large fingers.

The first section of the switch from the left is the power switch. This is a push-on push-off unit, and is fitted with a red knob.

The three middle switches are interlocked together, so that only one can be pushed in at a time. These are used to select one of three delay times available. They are all fitted with white knobs.

The fifth switch is a momentary contact one, and this is used for the single wipe function. It is fitted with a black knob.

Isostat switches are principally designed for use with a printed circuit board, any other form of connection being difficult, so use of these switches necessitated use of a small PCB.

The only other major decision to be made concerned the means of obtaining the required delay. We chose to implement this using a 555 type IC timer, as this needs a minimum of external parts, yet would give reliable operation.

Turning now to Fig. 1, we can examine the way in which we have implemented our design.

The three interlocked switches, S2, S3 and S4, are wired so that the three trimpots are normally shorted. Thus when S2 is pushed, the 10k trimpot is placed in series with the 4.7k limiting resistor, when S3 is pushed, the 47k trimpot is selected, and when S4 is pushed, the 220k trimpot is selected.

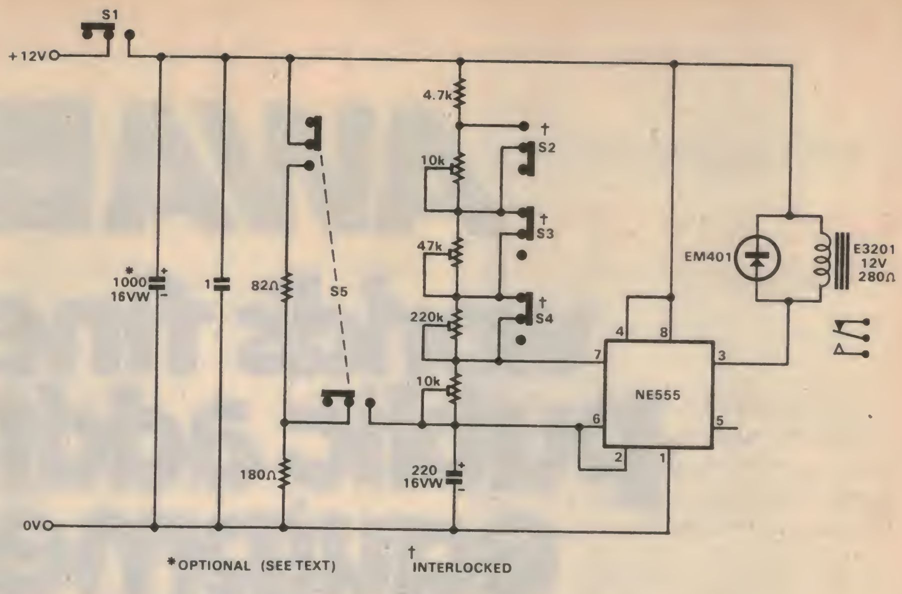


Fig. 1: the circuit diagram for the Variable Delay Wiper control. The use of a relay output stage makes possible the control of most types of wipers.

The 4.7k limiting resistor is required to prevent pin 7 being shorted to the positive supply rail if the switches are manipulated so that none of them are pushed in. Similarly, if two or more are pushed in at once, the trimpots are connected in series. This arrangement was necessary to prevent damage if the switches were manipulated in a non-standard manner.

The selected trimpot, in conjunction with the second 10k trimpot, determines the charge time of the 220uF capacitor. This is the off time of the relay, corresponding to the wait between wipes. The 10k, 47k and 220k trimpots are all individually adjustable to achieve three separate delays.

The discharge time is determined solely by the second 10k trimpot, and this is adjusted to suit the particular wipers. During the discharge time, the relay is energised, and corresponds to the start of the wipe.

Although our prototype used trimpots, and we have shown them in the circuit diagram, it may be an advantage to replace them with fixed resistors, in the interests of reliability. In this case it would be best to use a trimpot to adjust the various delays, and then measure the values and fit fixed resistors of the same value.

The relay is driven directly from the output terminal of the 555 timer. Note that a protective diode is required, to prevent latch-up due to the inductive spikes produced when the relay is de-energised.

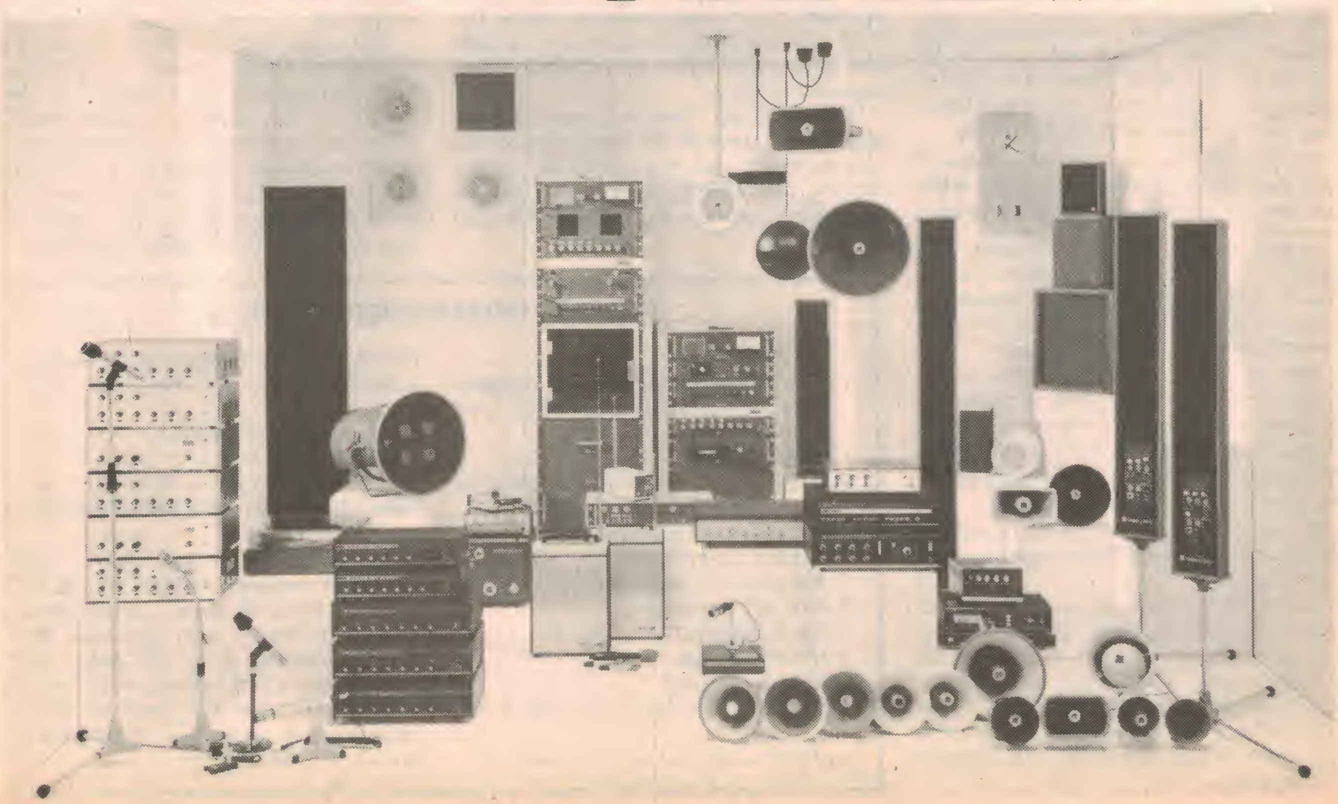
The single wipe facility is obtained by forcing the 220uF capacitor to full charge. This corresponds to a voltage of two-thirds of the supply voltage, and is achieved by means of a low impedance resistive divider formed by the 180 ohm and 82 ohm resistors. As this divider puts a considerable load on the supply rail, it is only connected when required.

LIST OF COMPONENT PARTS

1 555 timer.
1 12V 280 ohm relay, single change-over, Associated Controls type E3201 or similar.
1 EM401 diode.
1 220uF PCB mounting electrolytic capacitor.
1 1uF polyester capacitor.
1 82 ohm ½W resistor.
1 180 ohm ½W resistor.
1 4.7k ½W resistor.
1 10k preset pot.
1 47k preset pot.
1 220k preset pot.
1 printed circuit board, EA 75w3, 150 x 80mm.
1 plastic case, 127 x 65 x 41mm.
1 Isostat 5-push-button switch assembly (McMurdo reference no. 3600-5).
1 5-way terminal block.

Miscellaneous
Solder, hookup wire, brackets, machine screws and nuts, 10mm spacers.

Note: Resistor wattage ratings and capacitor voltage ratings are those used for our prototype. Components with high ratings may generally be used, providing they are physically compatible. Components with lower ratings may also be used in some cases if available, providing ratings are not exceeded.



Such a low impedance divider is required to ensure that the capacitor is charged almost immediately.

It is necessary to filter the supply voltage to prevent ignition transients and surges due to load changes on the car electrics from falsely triggering the timer. This is achieved by the 1uF capacitor. In extreme cases, it may be necessary to fit a 1000uF electrolytic capacitor as well.

Before describing the construction of the unit, we will digress and give a short explanation of the various types of electric wipers commonly fitted to cars. Table 1 is a list of the more common types, and their identifying characteristics.

The earliest types of motors employed a wound field, and these were characterised by a good self-braking action. All that is required to control them is a simple on-off switch. Self parking is achieved by using a second, mechanically linked switch in parallel, which keeps power applied until the parking position is reached. Fig. 2 is a schematic diagram of such a system.

However, the more recent type of permanent magnet motor does not have the same braking characteristics, and it is necessary to apply dynamic braking by placing a short across the armature. Fig. 3 is a representative schematic circuit for these types of motors.

In the on position, the wiper motor is connected directly to the 12V supply. As the motor rotates, it operates a synchronised change-over switch. In the diagram, this switch is shown in the self-parking position, and it can be seen that there is a short directly across the motor armature.

When the wipers are turned off, the armature is earthed via the "B" contact on the wiper switch, and by the cam-actuated switch, so that the motor continues to operate. However, when the cam-actuated switch operates, it shorts out the armature, bringing the motor, and hence the wipers, to a stop. The cam is arranged so that this occurs at the bottom of the windscreen.

TABLE 1: Windscreen Motor Systems

No. of speeds	Type of Motor	No. of wires to switch	System code
1	wound field	2	1
1	wound fld, not self-parking	2	1a
2	wound field	3	2
1	permanent mag.	3	3
2	permanent mag.	4	4
cont. variable	not suitable for use with our timer		

A list of the most common types of windscreen wiper motors is given in Table 1

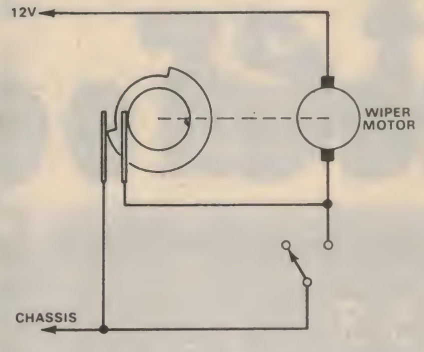


FIG. 2 SELF PARKING WOUND FIELD TYPE MOTOR SHOWN IN PARKED POSITION

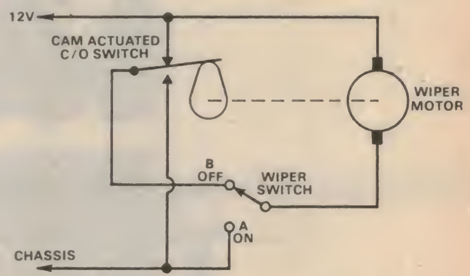


FIG 3 TYPICAL PERMANENT MAGNET MOTOR SHOWN IN PARKED POSITION

For all types of motors, our relay must act in a parallel fashion, so that it will turn on the wipers when the main switch is turned off, but not interfere when the main wiper is turned on. In order to do this, it is essential to use a relay with break before make contacts, such as the one specified in the parts list.

With all types of two-speed wipers, we recommend that in the intermittent mode, the slow speed is used. This will help to minimise the current through the relay contacts on switch on without seriously affecting the wiping action.

Construction of the unit should be relatively easy, as most of the components are mounted on a printed circuit board. The first stage is to mount the switch assembly on the PCB. This must be fitted with the momentary contact switch on the right hand end, as shown in the photographs. Do not push the switch right down onto the PCB, as otherwise there will not be enough clearance above the relay.

When fitting the remaining components, take care to fit them with the correct polarity. The two trimpots on the right hand end must be fitted so that their wipers do not touch, as shown in the photograph. PCB pins can be fitted to the relay outputs, as well as the power supply points.

The PCB and switch assembly is held into the plastic case by two countersunk machine screws, in conjunction with nylon spacers. We used extra nuts to lengthen the spacers, as this gave a better appearance from the front. Before fitting the PCB, drill five clearance holes for the wires to the terminal block, and fit and wire it.

The suppression components, which are not fitted onto the PCB, can be wired directly between the negative supply input and one of the tags on top of the power switch. Our photograph shows how we fitted the 1uF capacitor. If needed, the 1000uF electro. can be fitted in a similar manner, or it can be wired directly across the terminal block.

Once construction is complete, the unit can be installed in the car. A small bracket must be made, to hold the case to the underside of the dashboard. We have left the details of this to the individual constructor, as it will have to be made to suit each individual car and mounting point

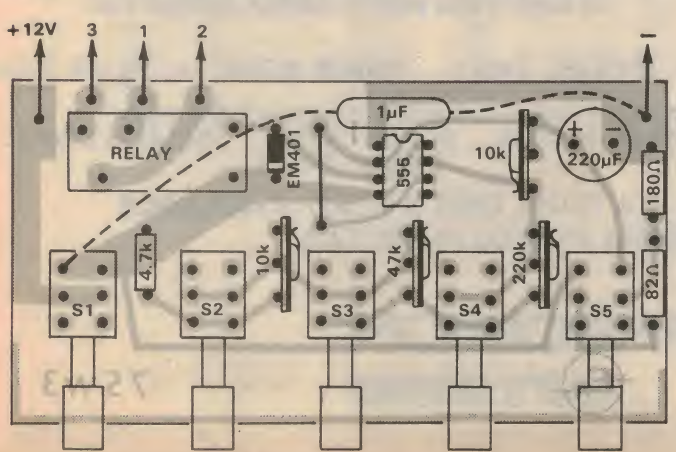
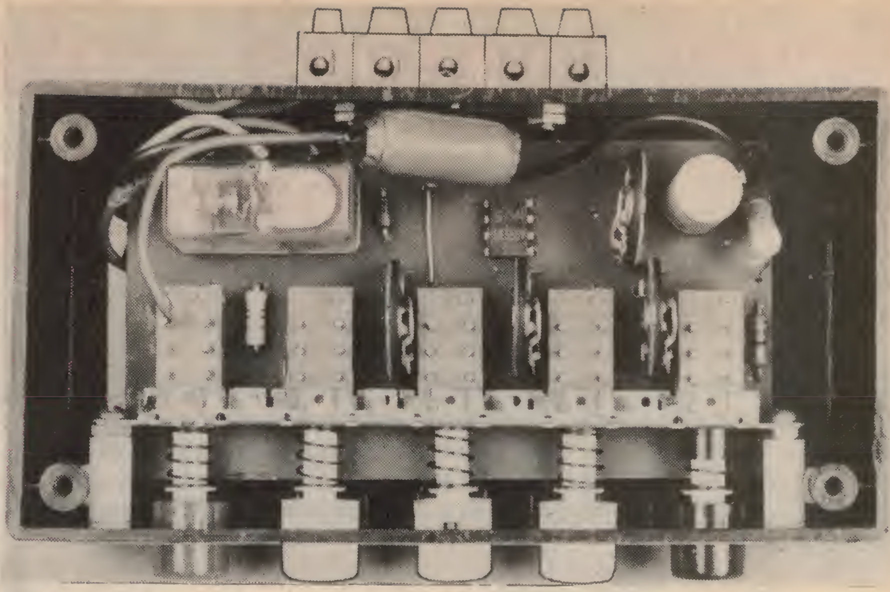
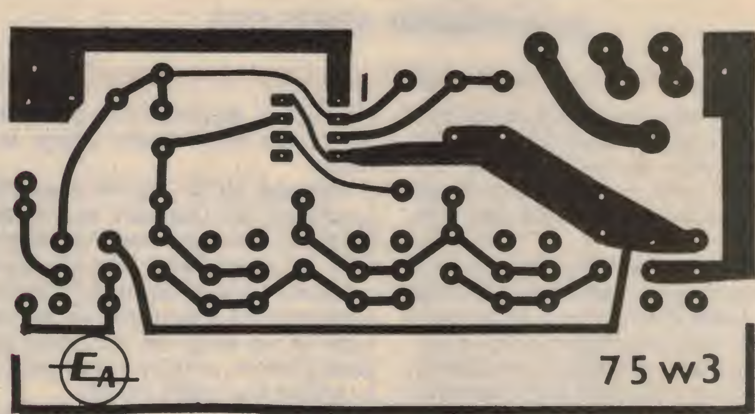


FIG. 5

The component layout for the Variable Delay Wiper control. For greater reliability, fixed resistors may be wired in place of the trimpots once the values of these are known.

Variable Delay Wiper





An interior view of the completed prototype is shown at top. Directly above is the printed circuit board pattern, shown actual size to facilitate tracing.

The next step is to complete the wiring to the electronics. First check to see if the wiring has a positive or a negative earth. If the car has a positive earth, connect the positive supply lead to some convenient earth point. It is a good idea to check with an ohmmeter that the point chosen is in fact connected to the main metalwork of the car, particularly in cars using plastic materials for the internal fittings.

If the car has a negative earth system, connect the negative supply wire to an earth point. The remaining supply wire (negative for a positive earth car, positive for a negative earth car), must be connected via the ignition switch. If your car has an accessories position, then connect this wire so that the unit will operate in this position.

Perhaps the most convenient place to connect the wire is near the fuses. Take care to connect the wire so that the unit is protected by the fuse. Connect a voltmeter between the proposed take off point and chassis, being careful to observe polarities. When the fuse is removed, the voltage should fall to zero.

It will now be possible to check the operation of the electronics. Switch on the motor, and press the timer power switch. It should be possible to hear the operation of the relay, as the various buttons are pressed. When the single button is pressed, the relay should operate for as long as the button is pressed, and for a short time after it is released.

The trimpots can now be adjusted. The 10k one nearest the 220uF electro is set to give the relay an on time of about half a second, and the remaining ones so that suitable delays are obtained.

The next step is to connect the wipers into the circuit. First ascertain what type of wipers are fitted. Table 1 is a list of the more common types. Fig. 4 gives the coding scheme we have used for the relay contacts.

We will consider system No.1 first. This type is usually fitted to early model English cars, and uses a wound field type motor with self parking facilities. There are two wires connected to the wiper switch, which is a single pole type. Connect the normally open relay contacts (2 & 3) in parallel with the wiper switch.

System No. 1a is very similar, but does not have self parking facilities. Our wiper control can be used with these wipers. Connect the normally open relay contacts (2 and 3) in parallel with the wiper switch, and adjust the on time of the relay so that the wipers give only one wipe. It will be found that this cannot be done exactly, due to the loading effects of the windscreen on the motor, but satisfactory operation can be obtained.

System No. 2 has a wound field type motor, with two speeds. There are three wires to the wiper switch. Turn the wipers on, and find and mark the wire which stops both fast and slow speeds, and the one which affects only the slow speed. Connect the normally open relay contacts (2 and 3) in parallel with the two marked ones.

System No. 3 uses a permanent magnet motor fitted with dynamic braking. There are three wires connected to the wiper switch. Identify the ground wire, i.e., the one connected to the car chassis, and mark it "A". Turn on the wipers, and find one of the two remaining wires which does not affect the operation of the wipers. The correct wire is the one which prevents the self parking facility from working. Without this wire connected, the wipers should not self park. Mark this wire "B".

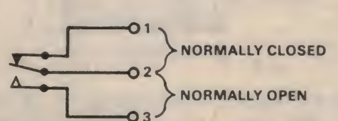


FIG. 4 RELAY CONTACTS SHOWN IN UNENERGISED POSITION

Fig. 4: the coding scheme used for the relay contacts (see text for connections).

Cut wire "B", and connect relay contacts 1 and 2 across the break, with contact 2 nearest to the switch. Contact 3 is then connected onto the earth wire A".

The last system to be considered is No. 4. This uses a permanent magnet motor with dynamic braking, but has two speeds. The procedure is very similar to that used for No. 3. Identify the earth wire, and mark it "A". Turn on the wipers in the slow speed position, and find one of the three remaining wires which does not stop the wipers, but does stop the self parking when disconnected. Mark this wire "B".

Cut wire "B", and connect relay contacts 1 and 2 across the break, with contact 2 nearest to the switch. Contact 3 is then connected onto the earth wire "A".

Having completed installation, the unit can be given a final checkout, and if necessary the trimpots readjusted. Turn on other electrical devices fitted to the car, such as the headlights and turn indicating systems, and check to see if the timer is being triggered by the resultant pulses. If so, it may be necessary to fit a 1000uF electrolytic capacitor across the supply lines.

Novel tapered column for "super bass" response

If you're a hifi or organ enthusiast with an urge to reproduce the lowest octave of fundamental bass, you will be interested in the novel approach suggested in this article. Instead of taking up floor space, which is at a premium in most homes, the tapered column enclosure can be mounted against a wall, hopefully in a position where it will be relatively inconspicuous.

by BERNARD SIMPSON*

Like many other projects, it started one wet weekend. At least that's when the idea started to invade the consciousness, but the practical steps awaited many weeks and a chance acquisition of the necessary components.

I have always been fond of organ music, the satisfactory reproduction of which calls for loudspeakers which are competent in the deep bass region, and for amplifiers capable of delivering a continuous block of power without wilting. I have had good results with my systems over the years, in stereo and more lately in the various kinds of four-channel that have come along. Even musicians who are organists have commented favourably, and that's good enough for me.

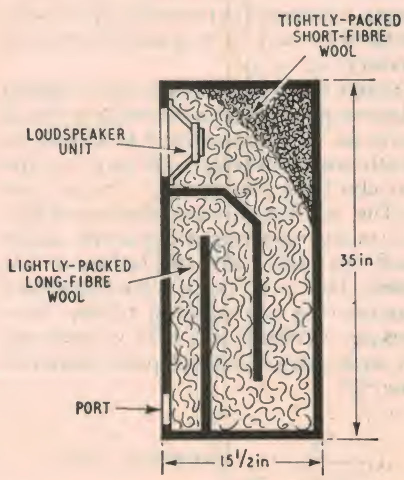
I do have the advantage of a room of reasonable size, where the dimensions are not inhibitive of deep bass reproduction. I did calculate the eigen tones some years ago, and whilst I do not remember all the figures, I do remember the lowest one was down towards 20Hz. This, together with loudspeakers of very good quality, has produced very satisfactory results.

But human beings are always striving for better things, even if instinct suggests there may not be much more to achieve. Besides, any of us, however hardened by years of experiment, can still get fired up reading about the adventures of others. And that is what happened to me.

I was turning over some old photocopies made on the basis of "I might want to refer to that one day", when I came across an item "The Super Woofer", by Nate Garfinkle, HI FI NEWS, July 1969. The article discussed briefly an exercise in which the deep bass was lifted by using a suitable loudspeaker and enclosure, whilst limiting the frequency range of the auxiliary system by the use of a low pass filter with a cut off at about 70Hz. The author used a combined channel system with one loudspeaker for the auxiliary system, but suggested the possibility of using such an auxiliary system in full stereo.

Although HI FI NEWS is an English periodical, Mr Garfinkle is a citizen of the USA. His object was to provide deep bass to accompany two electrostatic speakers. Clearly the improvements he reported were dependent on the equipment he was using and the results he was getting before, so there was no great point in getting too wildly excited.

Some points were noted: An electronic low-level low-pass filter was used to avoid large inductors. The loudspeaker/enclosure combination used must be inherently capable of real bass performance. The author mentioned he would have liked to have used a KEF B 139 in an arrangement similar to that described by Dr. A. R. Bailey in "A Non-Resonant Loudspeaker Enclosure Design", WIRELESS WORLD, October 1965, but the B 139 (at that time) was not available to him in the USA. It goes without saying that a quick scrabble around produced the WIRELESS WORLD article, and also a very interesting letter on the subject from E. A. Harman, published in the December 1965 issue.



This enclosure, described by A. R. Bailey in "Wireless World" (Oct 1965) has been the subject of much argument but it has one thing in its favour: it works! It was the starting point for the vertical column described here.

The combination of the Bailey enclosure and the B 139 was clearly the kind of design required if the auxiliary bass channel was to be tried. Furthermore, there was the interesting possibility for the experimenter in varying the density of the medium inside the enclosure. However, remembering that many homes are shared by wives, the Bailey enclosures are not tiny. A saving thought was that if the enclosure were only for auxiliary bass, location in the room would not be determined by the usual speaker placement considerations.

At this stage, as so often happens, the idea passed off centre-stage into the subconscious. It received a shock revival one Saturday when, scanning the hifi ads in the morning paper, I saw someone offering a pair of B 139's "new in cartoons" at a very attractive price. A quick use of my horseless carriage led to the translation of these two goodies into my possession. And having bought them, obviously I had to use them. But how?

No one is going to be interested in all the thought processes, so suffice it to say that a solution was found. There is a corner space in my listening room between a door and a wall, where nobody ever goes. Something placed there would be virtually invisible. At this stage I had a space which did not fit two of Dr. Bailey's enclosures.

But these enclosures are folded—how about unfolding them? A scaled-up sketch of the enclosure was made so that such things as mean path length through the enclosure could be checked. A few simple calculations confirmed the major dimensions and ironed out errors arising from scaling up a very small drawing. A straight, tapered tube was then drawn up embracing the important dimensions. After some fiddling with sizes to provide a cross-sectional area tube to accept the B 139, a double side-by-side tapered tube was drawn up, which could just be accommodated in the space available.

There are a couple of points about this

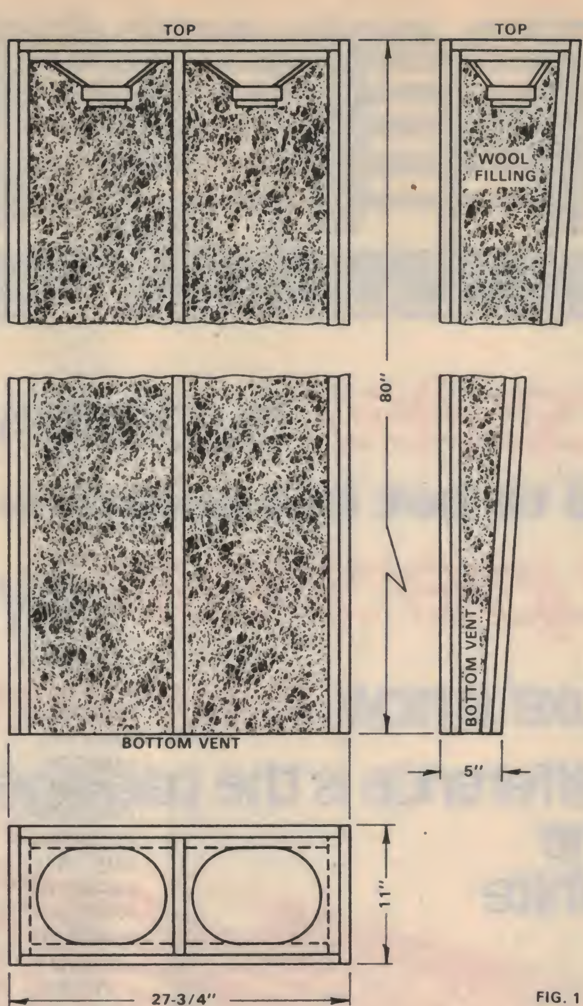


FIG. 1

Ever an enthusiast, the Author built up a twin column with two loudspeakers, one for each stereo channel. For the ordinary domestic scene, a single channel would be adequate, fed with signals taken from both channels. The enclosure needs to be very solidly constructed but the method of assembly can be varied to suit facilities. Dimensions are not highly critical and other high performance woofers could be utilised.

*6 Eden Avenue, Turramurra 2074. Bernard Simpson was formerly editor of "Radiotronics" and is a well known writer on hifi topics.

double enclosure. One is that the simple construction brings the speakers into a position where the axis through the coil is vertical. The literature has some criticism of this orientation of speakers, claiming that the cone will sag. Maybe it will, but it is good enough for experiment—modification to turn the speakers onto a horizontal axis could come later.

The second point is that the "port" ends of the tubes are adjacent. This has been claimed by some to have a mutual augmentation effect. I have no strong feelings on this, as the two speakers are usually not reproducing exactly the same material, and theories could be down the drain.

The double enclosure finally constructed is sketched in Fig. 1. Construction is of ¾" chip board and 1" x 1" D.A.R. soft wood. Obviously the detail could be varied to suit circumstances. The tubes must be airtight at the seams. This calls for accurate cutting and fitting of the two sides and the centre divider in particular. Various sealing substances are available and have received mention in articles on building enclosures. Working and fitting to fairly close tolerances, one of my favourites for many years has been a liberal application of BOSTIK shortly before assembly. The assembly method used was glueing and screwing.

My enclosure was constructed so that the sloping panel covering the two tubes, which was to be the front of the unit, was placed into position and screwed down last, after the wool was packed in. The entire enclosure was affixed to a wall with the openings clear of the floor. It is not easy to make such a tall unit free-standing, but a way could surely be devised if necessary.

The opening at the bottom of the enclosure needs provision to prevent the wool filling from coming out, and also to prevent bugs (of the flying or crawling variety) from getting in.

The solution is easy. After assembly of the main body of the enclosure, a piece of fly wire, of the metal rather than the plastic kind, is affixed to the bottom across the openings. Towards the front, where it is to meet the front panel, the edge may be turned up. This not only stiffens the edge of the wire, but provides an edge which can be compressed slightly when the front panel is placed in position, thus making sure that there are no openings left past the wire.

I use a kg. of raw, long-fibred wool (fibres about 10cm. long) for each tube, a total of 2 kg for the project. This amount is within the range suggested by Dr. Bailey and confirmed by Mr. Harman.

Supplies of suitable wool are much more readily available in Australia than

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"SUPER BASS" RESPONSE

Dr. Bailey found in England. I got mine from a specialist spinning/weaving supplies shop. The biggest task apart from the basic carpentry was preparing the wool. There was some vegetable matter to be removed, and a few soiled areas to be cut off. The whole of the wool was then pulled and teased out into an enormous fluffy, homogeneous mass, and finally packed into the tubes.

In working with this wool it became clear why Dr. Bailey used wool in preference to other materials. The springy-ness of the fluffy mass is astonishing, whilst its homogeneity when treated in this way is superior to that of other possible materials I know. It is worth recalling, as pointed out in Mr. Harman's letter, that the function of the filling material is effectively to increase the density of the sound-transmitting medium in the tube, and therefore the more even the distribution of the filling material, the better.

I was fortunate to have a spare stereo amplifier to drive the auxiliary bass speakers, so that there remained only the low-pass filter. Mr. Garfinkle provided a design which was quite satisfactory. All I had to do was to copy it using locally-available components. For the sake of completeness, my version is shown in Fig. 2, two filters being needed for two channels. I tapped off two channels from my "front" amplifier after the tone controls, through the two low-pass filters and into the auxiliary input of the spare amplifier, with preset level adjusting controls.

By setting the auxiliary bass amplifier tone controls top "flat", the whole "front" area of the sound was then controlled by the tone controls on the "front" amplifier. Incidentally, the filter draws only a few milliamps, so that it can be energised from virtually any convenient source.

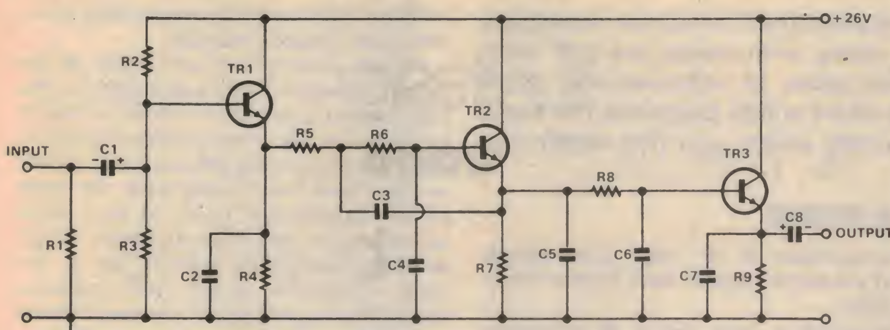


FIG 2

Fig. 2: Low-pass preamplifier used to segregate low frequency signals. If common to stereo channels, isolating resistors would be necessary.

Listening results? Well they can be dreadful with any augmentation system unless it is used intelligently. There is an initial temptation to wind up the auxiliary bass too far, particularly if the other speakers in the system have not been doing so well in the deep bass region. Careful adjustment produces a subtle but satisfying result, at times a matter of feel rather than hearing.

The improvement depends on what one started off with, and is obviously available only on program material containing significant amounts of information below 70Hz.

Those who want more deep bass but find a couple of B 139's inhibiting may prefer to go along with Mr. Garfinkle and use one of everything driven by combined channel information. This single channel signal is easily derived from the two "front" stereo signals using a simple resistive network.

There are obviously several variants available on the electronics side, dependent for example on what amplifiers are available.

A word may be appropriate regarding the wool filling. I was not at first certain about the use of raw wool on a long-term basis, although it is no problem for experimenting. Scoured wool in the condition it must reach immediately prior to spinning would presumably be satisfactory, but I have not been able to locate a supply of the size required. In any case it would then be necessary to pack in a greater weight of scoured wool to produce the same effective density inside the tubes. However, enquiries have suggested that there is no long-term problem with the raw wool when the loose dirt and vegetable matter has been removed as described.

PARTS LIST FOR L.P. FILTER
(For one channel, duplicate for full stereo)

CAPACITORS

C1, C8	*10uF elec., 25 VW*
C2, C5, C7	*0.001uF poly.*
C3	*0.27uF poly.*
C4	*0.068uF poly.*
C6	*0.15uF poly.*

RESISTORS
(All ½W, 10%)

R1	*470K*
R2	*68K*
R3	*82K*
R4	*5.6K*
R5, R6, R8	*15K*
R7, R9	*10K*

SEMICONDUTORS
TR1, TR2, TR3 BC184L or equiv.

Building your own digital calculator—a guide

Although the cheapest way of getting an electronic calculator nowadays is to buy one completely assembled, many enthusiasts are still keen to build up their own. Apart from the sense of achievement, there is of course the educational value. This short article describes the basic operation of a modern calculator, and tells where you can obtain the parts needed to build one up.

by JAMIESON ROWE

Let's be realistic—if you want a cheap electronic calculator, building one yourself is not the way to get one. Nowadays, you can buy quite a nifty little 4-function pocket model for less than $20, from most department and bargain stores. So there's no money incentive in building one yourself, just the reverse in fact.

There isn't a great deal of educational value in building up a modern calculator, either. Virtually the only practical approach is to use one of the modern LSI (large-scale integration) calculator circuits, which typically comprises one large IC (integrated circuit) together with a few minor components, a keyboard and a display. All the real operation takes place inside the "black box" IC, so that you don't really learn very much from connecting it up.

But despite these sobering realities, there are undoubtedly quite a few people who do still want to build one, judging by the number of letters we get from readers asking for information on circuits and parts availability. We can only assume that it is for the sense of achievement—who said the amateur spirit had died?

If you're one of the hardy souls who do indeed want to build their own calculator, then, this article has been written for you. We hope it will help answer your questions, and give you all the basic information you need.

The basic items you'll need for either a pocket calculator or a desk type are the calculator IC or "chip", a keyboard, and a suitable display. Let's look at these in turn.

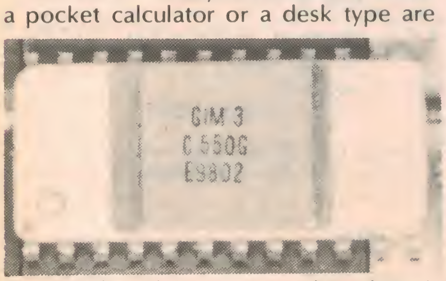
Nowadays, just about all electronic calculators are based on the "one-chip" concept, with a single LSI device performing all of the basic calculator functions. The device is usually in a large DIL (dual-in-line) package, with anything from 24 to 40 pins, and represents the most expensive single item required—typically it will cost around $20-30.

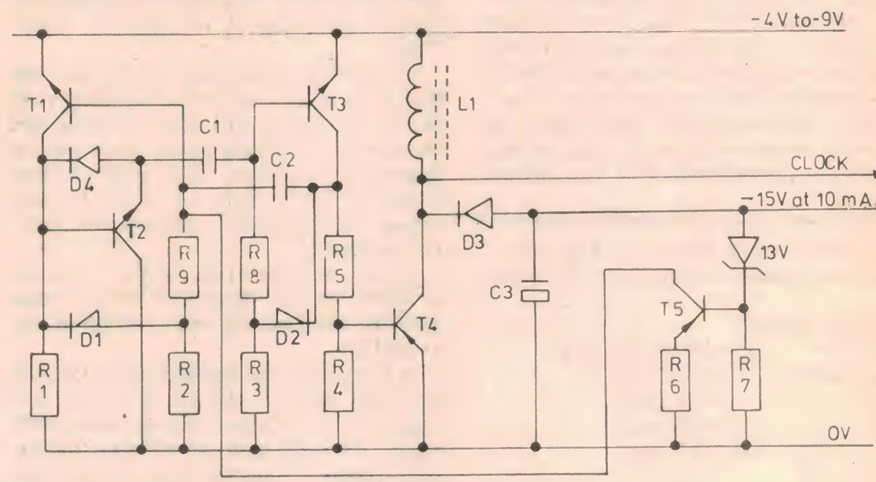
Almost every semiconductor manufacturer has produced one or more such calculator chips, while those who have specialised in the field have produced an almost dazzling array of devices ranging all the way from simple 4-function chips to quite elaborate and costly items offering multiple memory registers, logarithms, trig functions, exponential functions and programmability.

As yet, there aren't too many of the more elaborate devices available for the home constructor, at least in this country, because the big overseas manufacturers have been gobbling them up just as fast as they have been falling from the ends of the production lines. In fact there seem to be very few different chips available, and these tend to be of the basic 4-function variety—with perhaps the ability to perform chain calculations and calculations with a constant as a bonus.

One chip which does appear to be in good supply is the C-550, made by General Instrument Microelectronics. This is available from the local GIM agent, General Electronic Services, whose address is 99 Alexander Street, Crows Nest, NSW 2065. It costs $20 plus tax (15%).

The C-550 is a MOS device in a 24-pin ceramic DIL package. It is designed to perform the four normal arithmetic functions, with additional features such as chaining, constant storage, integral powers, and floating point on entry and result. It is designed to work into an 8-digit display unit, although the internal





R1.	3K9
R2.	68K
R3.	22K
R4.	1K
R5.	1K5
R6.	2K2
R7.	6K8
R8.	2K 2
R9.	2K 2
C1.	570PF
C2.	470PF
C3.	IMFD
L1.	35T ON MULLARD FX 2249 >2 mH

TRANSISTORS
NPN. 2N3904/BC108
PNP. 2N3904/BCY 71

Fig. 1 (right): The power supply and clock generator circuitry required for the GIM C-550 calculator chip. All the parts are listed. Above is a view of the chip itself, about twice size.

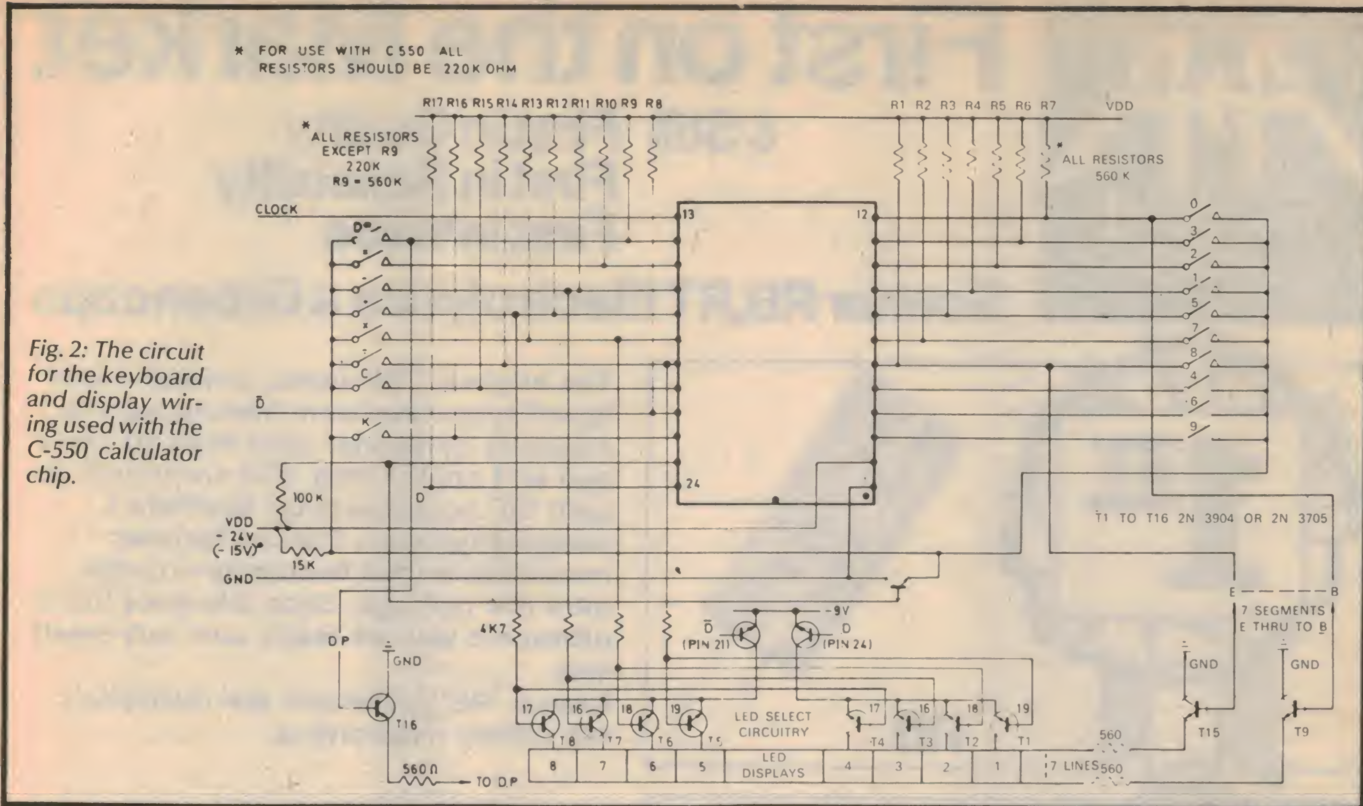


Fig. 2: The circuit for the keyboard and display wiring used with the C-550 calculator chip.

arithmetic is able to handle numbers varying in magnitude between 10^{-20} and 9.999999×10^{79}. The chip performs automatic overflow and underflow, so that any result within this range can be retrieved by multiplying or dividing by multiples of 10.

The chip is provided with integral protection against contact bounce in the input keyboard. It is capable of interfacing with a wide variety of displays, having an input/output multiplexing system whereby the multiplexed outputs for the display use the same device pins used by the input keyboard.

The C550 chip actually runs from 15V DC, drawing about 10mA. This is not directly compatible with the normal batteries used in portable or desk calculators, but the manufacturer suggests that this can be overcome by using a simple converter circuit. As the chip also needs an external 70kHz clock oscillator, the recommended scheme is to use a combined clock oscillator and converter, as shown in the circuit in Fig. 1.

As you can see, the circuit uses three NPN transistors (BC108 or similar), and two PNPs such as the BCY71 or similar. It uses a small inductor (L1) wound on a Philips FX 2249 ferrite core to develop the 15V clock pulses, which are rectified and regulated to provide the supply voltage to the C-550 chip. The circuit is designed to operate from a battery voltage of between 4 and 9V, with positive grounded.

The rest of the circuitry required to get the C550 going is shown in Fig. 2. Apart from the C550 chip itself, the display and the keyboard switches, the only other components are 19 general-purpose NPN transistors (BC108 or similar) and 31 resistors. The transistors are used mainly as display drivers, with T1-T8 as digit drivers, T9-T15 as segment drivers, T16 as the decimal point driver and a further two for digit driver decoding. The final device is used for input-output strobing. Resistors R1-R17 are used as pullup loads for the multiplexed input-output lines, while the remaining resistors are used mainly as current limiters in the segment lines and digit driver base lines.

The input keys connect to pins 3-12, 14-20 and 22. Of these, pins 6-12 inclusive are also used for the seven segment multiplex outputs, and pins 16-19 inclusive for the four main digit output lines. Pins 21 and 24 are used for the digit group decoding outputs, while pin 23 is used for the input-output strobe gating output. This last signal gates the transistor which controls the keyboard switch common line, so that the key switches are disabled when the common multiplex pins are performing their output function.

To go with the C550 chip you will need a keyboard assembly with a compatible set of switches and inscriptions. As it happens, such a keyboard is also available from General Electronic Services, the type 19SK-6 made by the Flex-Key Corporation. The cost is currently $18 plus tax (15%).

The 19SK-6 is a solidly made keyboard, featuring double-shot moulded keys. It has 18 keys, together with an on-off switch, and measures 71 x 91 x 15 mm overall. The contacts employed are of the conductive elastomer type, and are completely sealed against dust and liquids. The switch connections are specifically made to suit the C-550 chip, so that the two are directly compatible.

The third essential item required for a calculator is the display, as mentioned earlier. Here you have a little more flexibility, with at least two approaches. If you want to spend the least money, the most attractive type of display will be the type expressly designed for calculator use, having all of the digits integrated into a single package. This also gives the most compact arrangement, and hence the most promising if you want your calculator to be of the "pocket" variety.

This type of display also tends to be fairly modest in terms of current drain, which is important if your calculator is to be run from batteries. On the other hand the digits are usually rather small, and not perhaps the most suitable for a desk-type calculator. Here you may prefer an alternative approach, using eight single-digit LED readouts.

For the first approach, a suitable integrated 8-digit display is available from Hewlett-Packard. This is the type 5082-7448, which features high efficiency GaAsP LEDS giving good readability at current levels as low as 250uA average per segment. The digits are 2.67 mm (0.105 inches) high, but have a built-in plastic magnifying lens system to make them appear larger.

Current price of the 5082-7448 is $14.04 plus tax, and they should be available through any of the H-P distributors, or on order from them via your usual parts supplier. At this price, the H-P device probably represents the cheapest display

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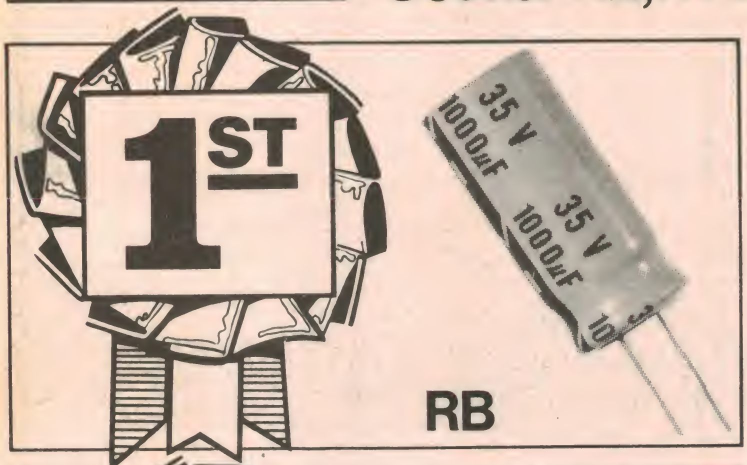

The original 'RB' series, printed circuit board capacitors were introduced into Australia by Soanar more than 10 years ago and are the only PCB electrolytic to gain full acceptance by Australia's design engineers. Special features include extended temperature range, ultra low leakage, close tolerance limits, ultrasonic welded leads and very small size.

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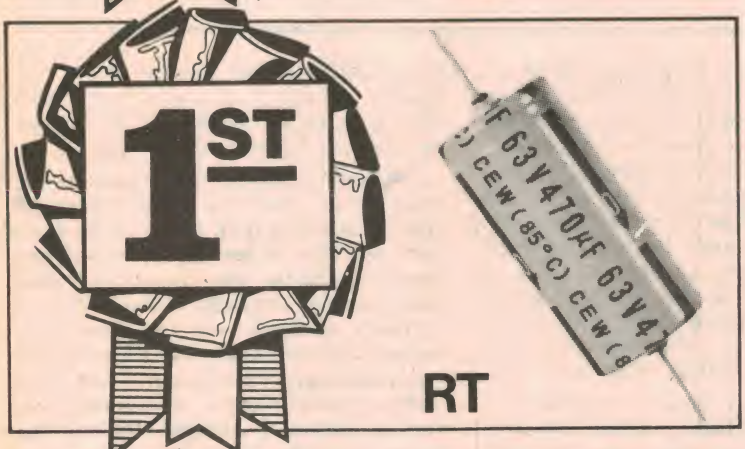

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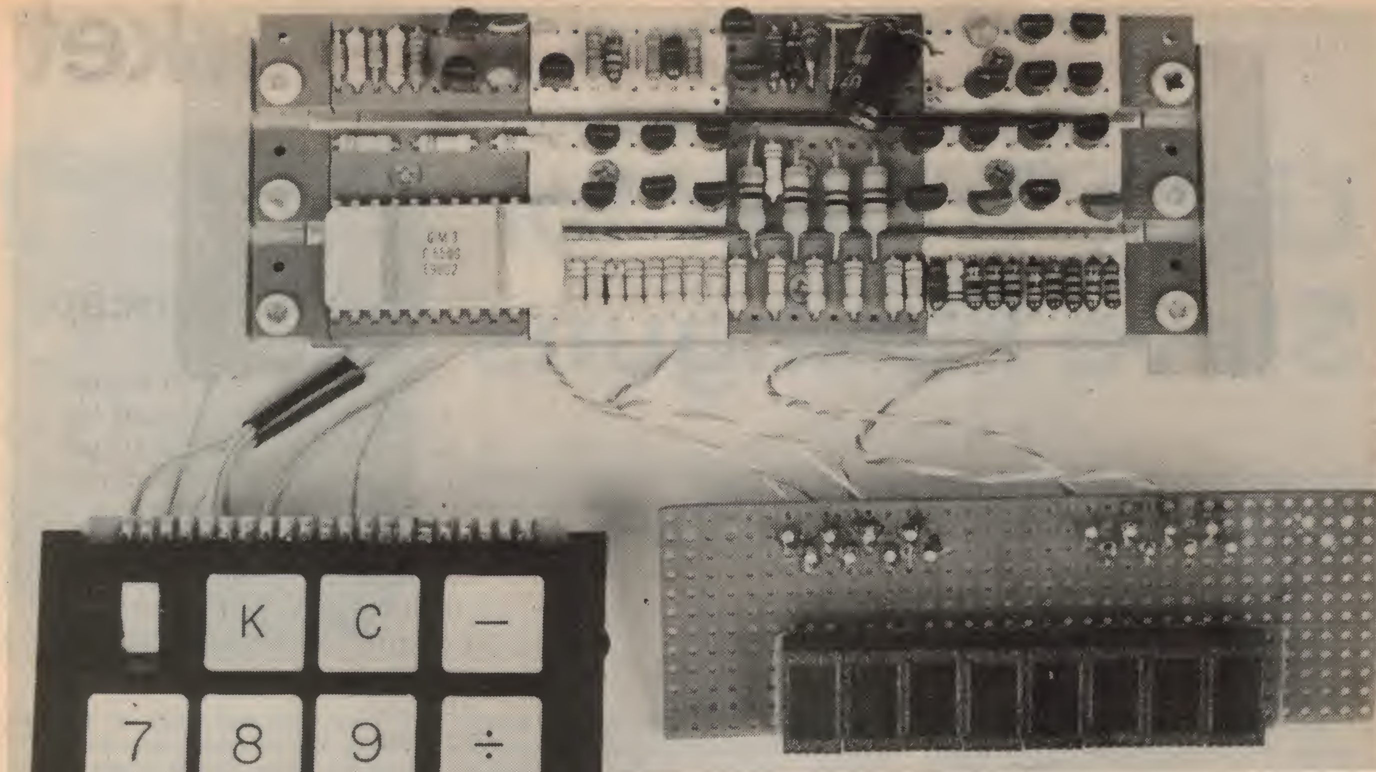



A basic demonstration calculator built up with the C-550 chip, the Flex-Key 19SK-6 keyboard, and eight Fairchild FND70 displays. The small parts are connected using wire wrapping, with hardware from the "Cambion" range handled by General Electronic Services.

for your calculator, by far—working out to about $2 per digit.

Litronix apparently have a similar device, the DL-95, which is available from Cema Distributors Pty Ltd, of 21 Chandos St, Crows Nest, NSW 2065.

If you opt for the individual readouts, there are quite a wide range of devices available. If you want big digits—0.6in—then you could use the Litronix type DL750. These are also available from Cema Distributors.

Hewlett-Packard also make a family of high-efficiency readouts with digits 0.43in high, and with a choice of either yellow or green emission as well as the usual LED-red (although their red is not quite the same as others, having been modified for greater readability). The red device is designated type 5082-7653, the yellow type 5082-7663 and the green type 5082-7673. The green device is not quite as efficient as the other two, but all three would probably be equally suitable for use in a mains-powered desk calculator.

These devices should be available on order from H-P distributors shortly, having been released in the US only a few months ago. The anticipated price at the time of writing is $4.56 each plus tax.

Another suitable readout device would be the Fairchild FND-70, as used in some of our digital instrument projects. This should be available ex stock from most parts suppliers, at a price of around $4.50 including tax.

The remaining aspects of building a calculator are largely a matter of personal choice, such as power supply, the type of construction used, and a suitable case.

The power supply will depend at least partly on whether you want a pocket calculator or a desk type. If you want the former, a battery supply is virtually unavoidable, whereas with a desk type you can use whichever you prefer. Don't forget, though, that the larger readout units tend to need a fairly high current, so that battery operation may not be very practical.

Typically the current drain for a calculator using the C-550 chip and a set of discrete readouts will be between 50 and 100mA at 9V. A suitable mains supply could therefore consist of a transformer with a centre-tapped 12V winding (or two 6V windings in series), with two silicon diodes in a full-wave rectifier, and a 1000uF/10VW electrolytic as the reservoir. One of the miniature 150mA transformers should be quite adequate.

You have a number of choices where construction is concerned. In most cases, the easiest approach will probably be to wire up the circuit on Veroboard or matrix board, as there are relatively few parts involved. However you could try your hand at designing a suitable PC board pattern, and making up a board using one of the do-it-yourself etching kits. Yet another alternative is to use wire-wrapping, as shown in the photograph; General Electronic Services can supply the hardware you need for this, along with a simple manual wire-wrap-ping tool.

As for a case, you're going to be on your own. There don't seem to be any suitable cases available, although one of the metalwork manufacturers such as Wardrope and Carroll Fabrications may be prepared to produce one if there is sufficient interest. Alternatively you could probably make up a simple case yourself, from a material such as Marviplate, or from wood covered with leatherette.

Footnote: This article is intended only as a guide for those experienced readers intending to build a calculator, and is not a constructional project. No further information will be available via the information service.

Ideal for amateur or professional . . .

Light Trigger for Slave Flashguns

As many keen photographers will attest, a slave flash can do wonders for picture composition. So here we present details of a simple slave flash trigger circuit which can be made into a compact module.

by LEO SIMPSON

Any reader who is keen on photography will already be aware of the uses to which a slave flash can be put. So apart from mentioning that it is often used for lighting the picture subject from the side or from above by a ceiling "bounce" to get a diffused effect, we will leave it at that.

The basic concept of a slave flash trigger is to have the slave flash actuated by the light "burst" from the main flash which is controlled by the camera contacts. To do this, the trigger circuit must use a light-activated semiconductor such as a LASCR or LASCS (light-activated silicon controlled switch) or a phototransistor.

Light-dependent resistors could also be used for this application but their relatively slow response times, which are generally of the order of a few milliseconds or so, may prove to be a disadvantage when rapid shutter speeds are required.

To understand the function of the slave trigger flash unit, which really substitutes for the camera contacts, one must be familiar with the circuit of a typical electronic flashgun. While these vary greatly in detail, they all use a transistor converter which changes the 3 to 12V battery voltage up to between 350 and 500V DC.

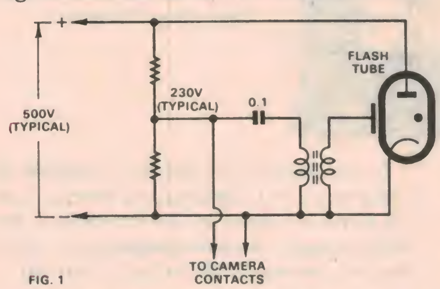
A typical electronic flash firing circuit is shown in Fig. 1.

A pulse transformer is used to fire the flash tube and this is energised in much the same way as the coil in an automotive capacitor-discharge ignition system. In the flash-gun though, the trigger capacitor is typically about 0.1uF. It is charged via the high resistance voltage divider and then discharged by the camera contacts via the primary of the pulse transformer.

Perhaps the simplest slave flash trigger circuit could merely use a light-actuated SCR in place of the camera contacts. The only other component required would be a suitable gate resistor for the LASCR. Unfortunately though, the few available types of LASCR presently available in Australia have a maximum continuous forward-blocking voltage rating of 200V. This is less than the voltage applied across the camera contacts by most electronic flash-guns. The types we measured were between 230V to 270V.

So that eliminates a "LASCR only" slave trigger circuit, at least for the time being.

Our approach was to use a readily available device, the Philips BPX66P light-actuated silicon controlled-switch.



A typical electronic flash firing circuit. Some use an SCR to discharge the capacitor, but the basic arrangement is the same.

Since this has an anode-cathode voltage rating of only 70V, it suffers from the same limitation as the LASCRs mentioned above—it cannot be used directly in place of camera flash contacts.

Instead, the BPX66P is used to discharge a small capacitor into the gate of a conventional SCR, which then in turn discharges the capacitor in the flashgun firing circuit.

A high resistance voltage divider comprising a 10 megohm and 1 megohm resistor is used to charge a 0.1uF capacitor from the 200-plus voltage impressed across the flashgun connector, while ensuring minimum loading (on that voltage).

If care were not taken to minimise loading, the internal capacitor in the flashtube firing circuit might not be charged sufficiently to ensure reliable operation, particularly as the batteries approach the end of their service life.

Almost any SCR can be used in the circuit, provided it has a continuous forward blocking voltage rating of more than 300V. This means that an SCR with a minimum rating of 400V must be used.

Clarification of that last sentence is required: An SCR with a general rating of 400V will usually have a lower figure applicable for the "continuous forward blocking" state. Hence, while the 300R version of the BT100A may seem suitable, for example, its continuous blocking voltage rating is only 200V.

If necessary, a 400V Triac can be used in this circuit in place of the SCR.

Construction of the trigger unit is not critical and several approaches may be used. Our prototype was assembled on a small section of Veroboard measuring 30 x 40mm, and used a 400V SCR in a TO-5 metal can.

Before wiring of the trigger circuit can be completed, the polarity of the voltage across the flashgun connector must be ascertained. Turn on the flashgun and measure the voltage and polarity across the socket using a multimeter switched to a high DC voltage range. Do not be surprised if the voltage is below 200V or conclude that use of a 200V SCR is permissible.

The apparently low voltage across the flashgun connector will be due to the loading effect of the meter. For example, a VTVM with a load resistance of 10M or a 20,000 ohm per volt meter on the 500V range (which results in a load of 10M) will reduce the voltage across typical flashgun connectors by 30 or 40 volts.

As noted above, a 400V Triac may be substituted for the SCR. Use a plastic

TO-66 or TO-126 type if possible. Anode 1 of the Triac is equivalent to the Cathode of the SCR while Anode 2 of the Triac is equivalent to the SCR Anode. Whatever is used, Triac or SCR, take careful note of the lead connections when wiring is in progress.

Having ascertained the voltage polarity, connect a suitable flash-gun socket to the trigger circuit using a short length of miniature figure-8 cable. The circuit board is now ready to be tested. Connect a flashgun and check that normal artificial room light impinging on the LASCS does not cause it to fire.

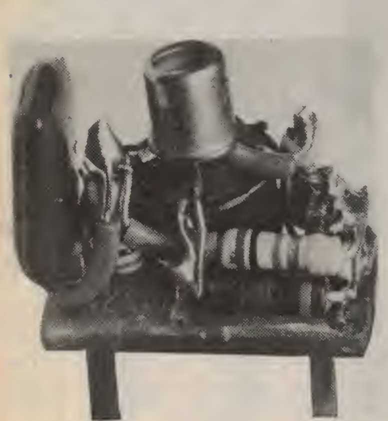
For this test, you can merely strap the trigger unit to the side of the flash using an elastic band. Check that the slave flash is triggered when in the vicinity of another flash (when it fires).

1M gate resistor of the LASCS.

We have tried the slave trigger out with a number of different flashguns, particularly the cheaper types which we felt most readers would be using. Operation with these types was very good.

However, when we tried the trigger on more expensive "professional" type flashguns, we found that with some the operation was unreliable. It appears many of these guns use an SCR in the firing circuit to protect camera contacts (mainly because they are likely to be used much more frequently). Instead of the contacts having to handle the firing capacitor discharge current of an amp or more, they pass only the SCR gate current—milliamps.

Because the current available through the sync contacts of these units is so low,



An alternative: The picture at left shows the slave trigger mounted on a 2 pin plug, as used in "professional" flashguns. The plug itself was made from blank PCB and 2 pins filed down from a mains plug. Right: The same trigger shown in position on the flash (circled).

With the LASCS "looking at" the main flash, it should be triggered at distances of up to 4 or 5 metres or more.

Bright sunlight will trigger the LASCS. For comparison, bright sunlight gives an illumination level of about 100,000 Lux, while recommended artificial illumination of classrooms and workshops is of the order of 100 Lux.

If readers find that the trigger circuit is too light-sensitive for their purpose, they may try the effect of reducing the the SCR in the slave trigger is not able to turn on properly. Therefore, the slave may not fire.

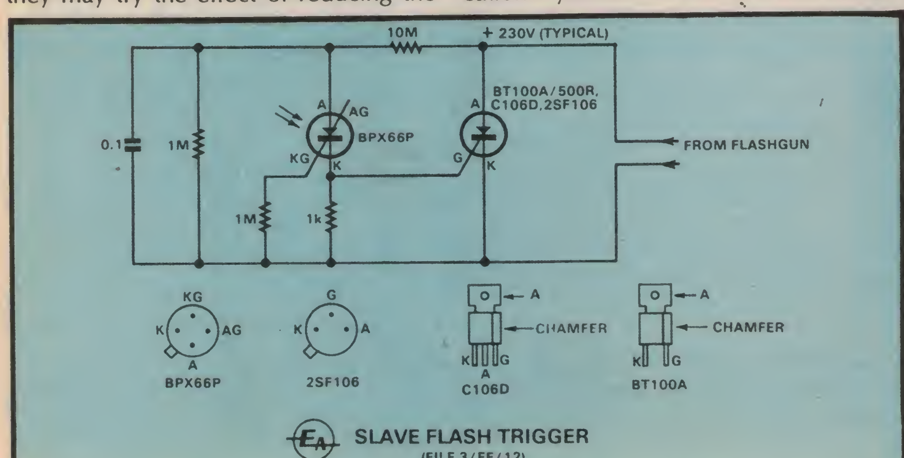
The easiest way to cure this is to place a 0.1uF capacitor directly across the SCR (anode to cathode). This creates an artificial reservoir which makes sure the SCR can fire when required. Note that this capacitor must be rated at 300V or more.

There is no need to make this modification if you do not intend to use a flash with SCR triggering. As most flashguns are not in this category, the modification is not shown on the circuit diagram.

When assembly of the trigger unit is complete and it has been checked for correct operation, the board can be cast into a block using a suitable epoxy resin. Only the top of the BPX66P should be protruding from the resin.

Velcro fabric fastener may be used to attach the completed encapsulation to the top or side of the slave flash. This allows it to be easily detached.

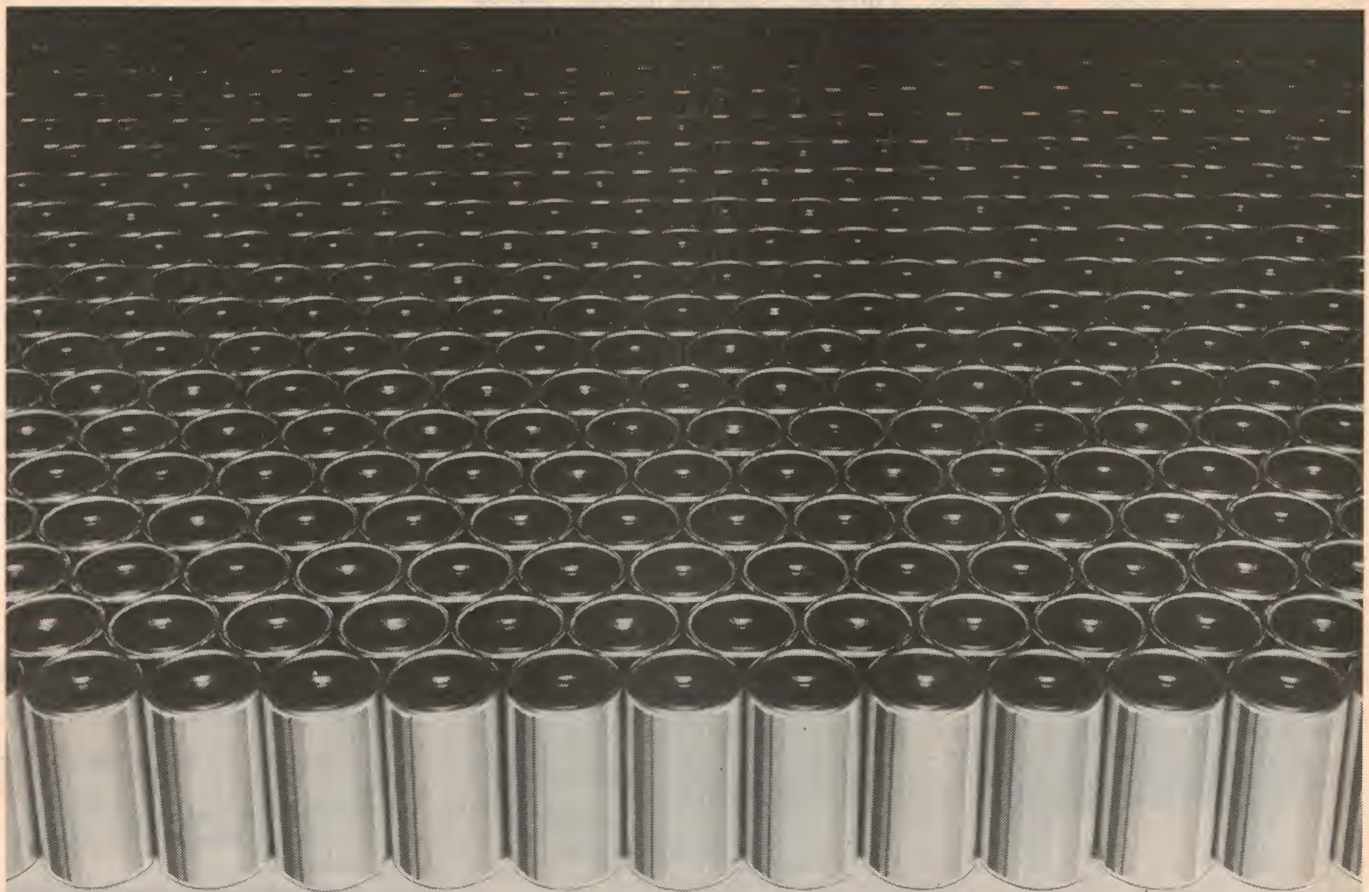
A variation of the method of assembly would be to wire the socket directly to the Veroboard and encapsulate it along with the rest of the components. Alternatively, if you have a "professional" flash with a two-pin socket on the side of the housing, the trigger circuit could be assembled on the back of the two-pin plug and then encapsulated in epoxy.



The circuit shows the simplicity of the slave trigger.

PARTS REQUIRED

1 small piece of Veroboard (optional)
1 flashgun connector socket
1 BPX66P LASCS
1 BT100A/500R, C106D or similar silicon controlled rectifier
1 x 0.1uF/100VW metallised polyester capacitor
1 x 10M, 2 x 1M, 1 x 1k, all ¼W or ½W resistors
Plus Velcro fastener, epoxy potting compound and short length of miniature figure-8 cable.



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What's new in Solid State

More CCD chips, and another LSI clock

Last month we reported the release by RCA of "big SID", a 525-line video imaging device using CCD (charge-coupled device) technology. Hard on the heels of this news has come the release of further exotic devices using the same technology. If nothing else, it suggests that CCD's have a big future.

Both of the new CCD devices are memory chips, of the serial or shift-register type. But what memories!

The first to be released comes from Fairchild. Designated the type CCD450, it comes in a standard 18-pin DIL package and is TTL compatible. It dissipates only 30mW in standby mode, and 250mW maximum. And the memory capacity? No less than 9,216 bits—organised as 9 x 1024-bit shift registers!

According to the brief details available, the CCD450 has a 3MHz data rate capability. It uses established ion-implanted buried-channel construction for the CCD registers, and Fairchild's Isoplanar N-channel MOS structure for the on-chip timing, charge detection and interface circuitry.

As if this device was not impressive enough, Intel have gone even further. Their new device, designated the 2416, offers a capacity of no less than 16,384 bits, organised as 64 x 256-bit shift registers.

Like the Fairchild device the Intel 2416 comes in an 18-pin DIL package. It dissipates 200mW at the rated data rate of 2MHz. Average access time of a bit in the device is 64us at a 1MHz shift rate.

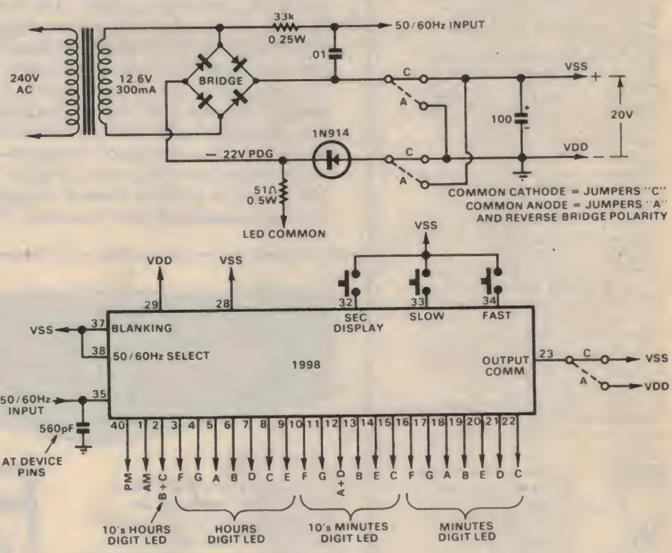
To demonstrate the potential of the 2416 device, Intel have built up a prototype memory board using 64 devices. Measuring only about 37 x 20cm, the board provides a 1,048,576-bit memory, organised as 131,072 x 8-bit words (bytes). This is comparable with the capacity of a magnetic disk or drum, and considerably faster!

Logical applications for both the new devices is as minicomputer and microcomputer memories, CRT terminal refresh memories, and any similar applications.

Cost of the Intel 2416 is quoted as $60 each in 100-off quantities, but presumably they'll come down in time.

Meanwhile on the local scene, Cema Distributors have announced that they have stocks of "yet another" digital clock chip, the S1998 from American Microsystems Inc (AMI).

The S1998 is rather like the National MM 5316 chip, in that it comes in a 40-pin DIL package and offers full alarm, snooze, timing and power failure alarm facilities. It also uses direct readout drive, rather than multiplexing, and is capable of directly driving displays using LEDs, fluorescent tubes, or liquid-crystal panels.



The circuit of a simple clock using the AMI S1998 chip and two Litronix DL728 dual-0.5in LED displays.

It can be programmed easily and simply for either AM/PM or 24-hour operation, and also for either 50Hz or 60Hz mains. It also has a blanking input which allows brightness control by duty cycle variation.

To show how easily the S1998 chip lends itself to the construction of a very simple clock, Cema built up a demonstration unit which teams the chip with two of the new Litronix dual-0.5in LED displays, type DL728. One of the displays was used upside-down, so that the two leading decimal points could be used to form a "colon" separating the hours and minutes figures.

This works out very neatly, and gives a display which is both compact and low in cost—considering the digit size. The DL728 dual displays are $6.53 plus tax in small quantities, which corresponds to about $3.50 per digit.

The complete clock circuit uses a mere handful of parts: the S1998 chip, two DL728 displays, a small 12.6V power transformer, a silicon bridge, two resistors, three capacitors and three pushbutton switches for time setting, etc. This is for a basic clock, of course, without alarm or snooze facilities.

The clock circuit can be used with displays having either a common anode or a common cathode, changeover being made quite simply by swapping three connections. Incidentally the Litronix dual displays are available in both versions, the DL728 being common cathode while the common anode version is DL727.

The address of Cema Distributors is 21 Chandos Street, Crows Nest 2065.

The final item this month is a new IC from National Semiconductor, the LM3909. This has apparently been designed mainly as a low-cost lamp flasher, but can also be used for thyristor triggering, timers, pulse and clock generators, and even in small DC-DC converters.

The LM3909 is a fairly simply monolithic chip, with about four internal transistors. But the design is such that it needs only a single external timing capacitor and a 1.5V cell to form a flasher circuit for an LED or a 50mA incandescent lamp.

The chip can deliver 200mA pulses to the load. It can also oscillate at up to 200kHz and beyond, for non-flasher use. It has an internal voltage regulator, and can be operated from supplies of up to 200V using an external dropping resistor.

As a single LED flasher, the LM3909 will operate off a single AA-size cell continuously for 3 months, or double that time from an alkaline AA cell.

Apart from its uses as a flasher, it should also be of interest for simple continuity testers, code practice oscillators, and simple pulse generators.

Further details would be available from NS Electronics offices in each state. (J.R.)

For further data on devices mentioned above, write on company letterhead to the firms or agents quoted. But devices should be obtained or ordered through your usual parts stockist.

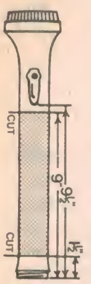
KITSETS

KIT'S KOLUMN

Woof. So much is happening I'm having trouble keeping up. First, we've got a new store opening in Melbourne at Box Hill which should please all the locals who have to trek miles to get what they want. And to all you studious types across the road at the Tech. College — come on in and say hello. Or drop me a line. (I didn't say hand me a line, Alfred E.).

You'll notice in this ad a bit about tools. Expense-account tells me good tools have been hard to come by and I'll have to accept his word for that. Although I've personally noticed no real shortage. However, when he showed me the new range, I saw what he meant. Beautiful solid stuff that should last for years. I only wish I could get eyebrow tweezers as good.

Back to the torch conversion. For all of you who have been following our breathtaking in-depth and fearless investigation of Mom (also known as Yankee doodle) here at last is our special expose of how to cut down your enormous 5-cell flashlight into a more economical 2-cell version, and save yourself 60% on battery refills.



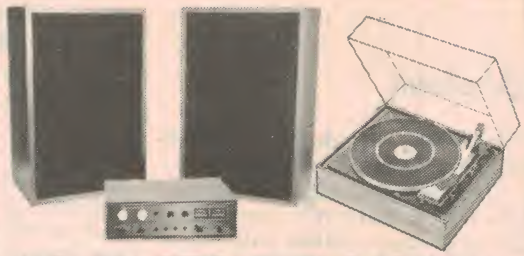
Scribe cutting lines on case as shown in diagram. Cut at switch end first, taking care not to damage metal strap. Cut other end of case. Align cut ends, then cement together. (Metal strap fits between case and pull-out metal ring.) Replace globe with 2.5 — 3V one, add 2 batteries and you're in business.

Had a nice letter from Richard H. Barton of Wellington New Zealand who seems to get marvellous circuit ideas in his bathtub. Love to see you if you're ever in Sydney, Richard. You sound like my type of experimenter.

Talking about New Zealand, and other nether parts of the world, it will be interesting to see where the best project ideas come from for our contest. (See details this ad.) But please, no black boxes — our friends at the APO would never forgive us.

Finally, to Alfred E. Neuman of Gore Hill, our special award of the Kitsets weeping handkerchief. Firstly, for maudlin nationalism, but mostly because he doesn't believe in me. Alf, how could you? (Autographed pic. sent free for S.A.E.) Until next month —

Keep your iron hot, *Kit*



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Mini-pro. Angled scale for easy reading. Test transistors! 20,000 ohms per volt DC, 8.000 ohms per volt AC. Has all the usuals including zero adjust, instruction booklet, leads. P&P $1.

$29·50

Economy master. Fits big pockets, has quarter-circle scale, mirror back. 20,000 ohms per volt DC, 10,000 ohms per volt AC. With leads, instruction sheet. One of our best buys. P&P 75c

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AD1256-W8 12" woofer. P&P $2. **$21.50.**

FAME AND FORTUNE ARE YOURS!

As we promised last month, here are details of our new contest where you can win big prizes for your favourite (own design) project. All you do is send us your original project design. Each month, we'll select a major prizewinner and runners-up. Winning projects will bear the entrants' names, and will be on sale as a kit through us. Get more details on the special entry form available from all Kitsets stores. If you can't call, write, and we'll send you one or how many you want. Grand prizewinner gets a full L&G colour plan Hi-Fi system at the end of the contest. This is your chance to lay your pet projects on us and maybe win a prize and see your name in print. No entry fee. Nothing to buy. Open to anyone. Get off your heat sink and get cracking — you'll never have a better chance!

NEW SQ DECODER KIT

Build this new 31CSQ decoder—incorporating both full logic and wave-matching. Connected between the tape out and tape in on your existing amplifier, and connected to a rear channel stereo amplifier it provides you with a fully decoded SQ sound. Our kit comes complete with all parts, including power supply, and a case about 8" x 2½" x 5½" plus sleek blackface front panel. P&P $2.50

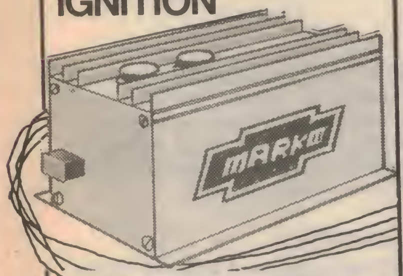
$59·50

SYDNEY: 400 Kent St., Sydney, 29 1005. 657 Pittwater Rd., Dee Why. 982 9790. **ADELAIDE:** 12 Peel St., Adelaide, 87 5505. **BRISBANE:** 293 St.Paul's Tce. Fortitude Valley, 52 8391. **MELBOURNE:** 271 Bridge Rd., Richmond (Gallery Level, Church St. entrance) 42 4651. **BOX HILL:** 985 Whitehorse Rd., Box Hill. **PERTH:** 557 Wellington St., Perth (Opp. new bus terminal), 21 3047.

BE FAST FOR HI-FI SAVINGS!

Ok Ok The secret's out To promote the sensational L&G colour-plan range, we recently set aside a number of tuner amps, turntables and complete systems to sell at vastly under normal prices. We're prepared to extend the offer to personal shoppers, or by mail order if you send for our discount coupon. Once promotional stocks are exhausted, we go back to old prices, so be quick.

Convert your car to ELECTRONIC IGNITION



This is not a kit. No assembling to do. Just hook it up and you've got CDI ignition. Improves fuel consumption, makes plugs and points last far longer. Can pay for itself in less than a year. Easy to check improved performance — simply press red button to change back to ordinary ignition, then press again for CDI. A beautifully finished unit, supplied complete with all necessary hook-up and mounting hardware. Suits all 12V negative earth cars.
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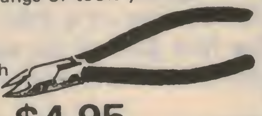
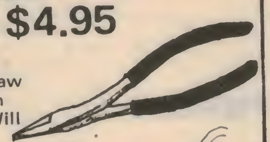
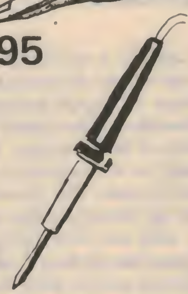


CUTTING PLIERS: Jaw depth 16mm; overall length 130mm. Tool steel with polished head, insulated handles. No. N32. P&P 60c **$4.95**



ROUND NOSE PLIERS: Jaw depth 30mm, overall length 175mm. Finish as above. Will actually pick up a human hair. No. P62. P&P 60c **$4.95**



SOLDERING IRONS: One of our most popular has been the famous Weller SP250. This was our special last month, and was gone in a flash. However, we now have new stocks, not at special price, but good buying anyhow at P&P $1. **$10.50**

SEE WHAT COLOUR YOUR MUSIC IS

NOT a kit. These are the spectacular SECO colour organs. Connect to any speaker and the colour lamps flicker and glow with varying brightness in relation to volume, pitch, and rhythm. Why put up with colour TV? Works even with small transistor radios. Leaves fibre-optic lamps for dead. **V3050:** Domestic unit. 30 lamps, 3 channels, 5 colours. Diamond pattern. 18½" x 11½" x 7 3/8". 3.5kg. P&P $2. **$49·50**

4050X: Professional monster. 32 lamps, 4 channels, 4 colours, individual colour mixing controls and a host of other features. Ideal groups. About 30½" x 15½" x 9 1/8".
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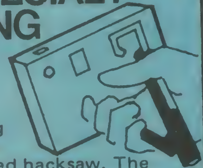

Stop sweating cutting holes with your tired hacksaw. The Hozan nibbling tool cuts any shape or opening by hand in sheet steel up to 0.06mm thick and soft metal up to 1.6mm thick. Squeeze-grip operation. We usually sell this for $7.95. During May, **for personal shoppers only,** we've reserved a limited number at each store to sell at the make-you-weep price of $5.95 each.

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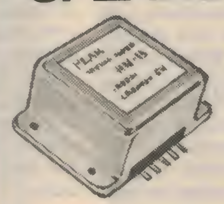

Neat little unit, with holes drilled ready for mounting. Easy to get at tag connectors. Hook up and you're away! 8 ohms impedance; crossover 1KHz & 5KHz. 2-way, P&P 60c. **$3.95.**
3-way, P&P 60c.
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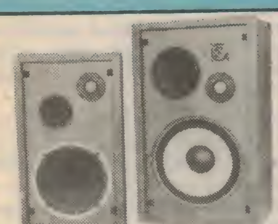

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V120: 12" woofer; 6½" middie; 1½ dome tweeter; 2" super tweeter. Crossover rolloff 12dB per octave; handles 45W RMS; 20-22000Hz. Has tone control. 25½" x 15" x 11½". P&P each $5. Price each **$112.**
V100: 10" woofer; 5" middie; 1½" dome tweeter. Handles 35W RMS, 20-20,000Hz. 22½" x 13" x 11½". P&P each $5. Price each **$89.**

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JMcA2199KS

Design for a PAL-S colour TV receiver—2

In response to the many favourable letters received since we published Mr Pierson's first article on the design of a PAL colour TV receiver, last June, we present here the first part of its sequel. In it, the author discusses various modifications and improvements to the original decoder design.

by ANDREW PIERSON

Following on from the information contained in the June 1974 issue, I have completed the design of the remaining colour recovery circuitry for a colour television receiver. As well as completing the (G-Y) matrix, luminance adding and sync facilities, I have taken advantage of a recent large price drop in the components market to make some very worthwhile improvements to the original decoder design—for a minimal increase in cost. The time which has elapsed since the appearance of the first article has been used to thoroughly research most of the possible circuit alternatives for a PAL-S decoder, whilst keeping within the constraints of the design philosophy outlined in part 1. It was felt that this time could be profitably put into research before the final circuit was committed to a PC card.

Coincident with this work was the development of an IF strip which could be simply aligned without using specialised equipment. Whilst this will be described in a later article, it is relevant to point out that the chroma information emerges at a much lower level (with respect to the luminance signal) than that found in conventional designs. The result of this is that the decoder must have higher chroma gain than normal, and also the chroma separation process must be carefully attended to, in order to minimise cross-colour interference.

Since regular test programs commenced, I have been able to carry out much more off-air testing. One of the most important things that I have learned is that a decoding system with immaculate specifications may be wasted in a domestic receiver, and, in fact, may be a definite hindrance. Take the chroma bandwidth, for instance—the wider it is, the more susceptible to noise and sound interference it becomes. So we make it narrower, but if we go too far, the coloured areas become visibly smeared.

With the above information in mind, I have now developed two separate colour recovery systems. The first (Mk II) has good specifications, and is intended for use with a colour camera chain, signal generator or a very clean off-air signal. The second system (Mk III) uses similar principles, but has lower chroma bandwidth and modified sync, ident and chroma blanking circuitry. This enables a subjectively better result to be obtained from off-air signals, and also allows the unit to operate from the simple IF strip.

This article will describe the Mk II system in detail, for the information of those readers who require a circuit that can be used as a versatile model to demonstrate the principles of colour TV signal processing. All the classic parameters can be varied, including individual phasing of both vectors. The burst is not suppressed, so the results of demodulating it can be readily seen. The chroma bandwidth can be varied (by changing the resistive damping on TR1), and the luminance delay can also be shortened (by tapping down the delay line). The APC circuit can be disconnected without affecting subcarrier locking, so that the effects of phase errors can be studied.

If you are contemplating the construction of a vectorscope, the Mk II system would be the best choice. The addition of a simple electrostatic CRT and deflection amplifiers would produce a very effective and economical instrument, and more will be said about this in a later article.

It should be stressed that the article which follows is not primarily intended to be a constructional one, but sufficient information is given to enable the equipment described to be reproduced if necessary. The present discussion is intended to be a lead-in to further articles which put several years of experimentation into practice with the description of a low-cost colour recovery system.

Subsequent articles in the series will describe the Mk III system, which is the obvious choice for a colour TV receiver project. This article will be constructional in nature, and the theory content will be limited to those sections which differ from the Mk II. It is worth noting that both the cost and complexity of the Mk III circuit have been considerably reduced.

EDITOR'S NOTE

The design presented in these articles is intended purely as a guide for experienced amateurs wishing to build a colour TV receiver on their own initiative. A complete receiver of this type is a complex piece of equipment, whose construction involves not only components worth hundreds of dollars, but a large amount of time and effort. We do not recommend such a project to those without a solid grounding in both theory and practical electronic equipment construction. Because of the specialised nature of the articles, neither Electronics Australia nor the author will be able to supply information on colour TV receiver design or construction further to that published, or in advance of material which may be published in future issues. Similarly we regret that we will not be in a position to assist readers privately with problems they may meet in constructing a colour TV receiver based on the designs presented.

THE Mk II SYSTEM

This equipment consists of a revised decoder design, plus the addition of the (G-Y) matrix, luminance delay line, luminance adders, and self-contained sync circuits. The result is a completely self-contained unit, i.e. 1V p-p composite video is fed in, and three 1V p-p signals corresponding to the red, green and blue components of the picture are available at the outputs. Since the subcarrier and ident recovery functions have been separated, the burst demodulation products are now meaningful, and may be very successfully used as an aid to alignment. As before, no special equipment is required for the alignment procedure, which may still be performed on ordinary program material. The power supply requirement is +12V at 380mA. It is true that the circuit employs more than 50 transistors, but it is also true that the devices specified are very inexpensive types. Also, bear in mind that the circuitry described represents a fair proportion of a complete colour TV receiver.

A description of the complete circuit now follows. Many sections are identical to the earlier design, and for detailed accounts of these the reader will be referred to part 1, in the June 1974 issue. A block diagram of the complete system is given in Fig 1, and this should be followed in conjunction with the circuit description.

CHROMA SEPARATION

Composite video is fed from the wiper of the CHROMA GAIN pot. RV1 to the base of the wide band amplifier Q1 via C1. The primary winding of the chroma bandpass transformer TR1 is included in the collector circuit of Q1, and the secondary winding is tuned to resonance at 4.43MHz by C2.

Since this circuit exhibits maximum impedance at its resonant frequency, the output signal amplitude will be maximum at 4.43MHz, the centre of the chroma passband. The Q of the circuit, and hence its bandwidth, is determined principally by the value of the damping resistor R5. The −6dB bandwidth is 1.6MHz.

Chroma signals from TR1 are passed to the amplifier stage Q2, which has a gain of 20dB and is DC coupled to Q3. A parallel-resonant 5.5MHz sound trap may be inserted here, but its presence has not been found necessary at this stage of development. Should it become desirable to include a filter at some later stage, the circuit designations L1 and C4 have been reserved for this purpose. Q3 is a unity gain amplifier, and is used to provide two signal paths—one for the synchronous demodulators and the other for the burst gating circuit. Its operation is described fully in part 1.

SYNC SYSTEM

Composite video is fed to the emitter follower Q4 via the low-pass filter R15-C7. The —6dB frequency of this network is approximately 600kHz, and it serves to prevent both sharp impulsive noise and the burst from reaching the sync separator. The purpose of Q4 is to buffer the low impedence input of the sync separator from the video input line.

Q5 is the sync separator, and is a PNP transistor biased in such a manner that collector current can flow only when the input signal is at or near its most negative excursions, i.e. during the sync pulse periods. Because the emitter is maintained at earth potential by C11 as far as the AC video signal is concerned, the base-emitter diode of Q5 acts with the input capacitor C9 to form a clamp circuit. This ensures that the sync tips are always maintained at approximately 650mV below the emitter voltage, regardless of the amplitude of the input signal. In this manner, correct operation of the sync separator circuit is maintained, even if the input signal amplitude should vary from its nominal 1V p-p.

The waveform available at the collector of Q5 is positive-going, and contains both line and frame information. The normal potential at this point is OV, with positive excursions occurring during the line sync periods. However, during the frame sync period the collector goes positive, and returns to earth during the line sync periods. Half-line pre- and post-equalizing pulses are also present. This is known as a 'composite sync' waveform. Since the ident recovery circuit can reset the ident flip-flop on every second line, it is quite possible to clock the flip-flop from this waveform. Any spurious triggering which occurs during the frame sync period will be corrected as soon as the bursts begin to appear after the four-field burst blanking sequence. Tests have shown that this method of clocking will be suitable for all except very noisy signals. It has been used because of its simplicity and also because sync facilities may now be easily incorporated within the decoder unit itself. Since the flip-flop operates on the negative edge of its clock pulse, the positive-going sync pulses are inverted by Q7 which enables the change of state to be coincident with the start of the line sync pulse.

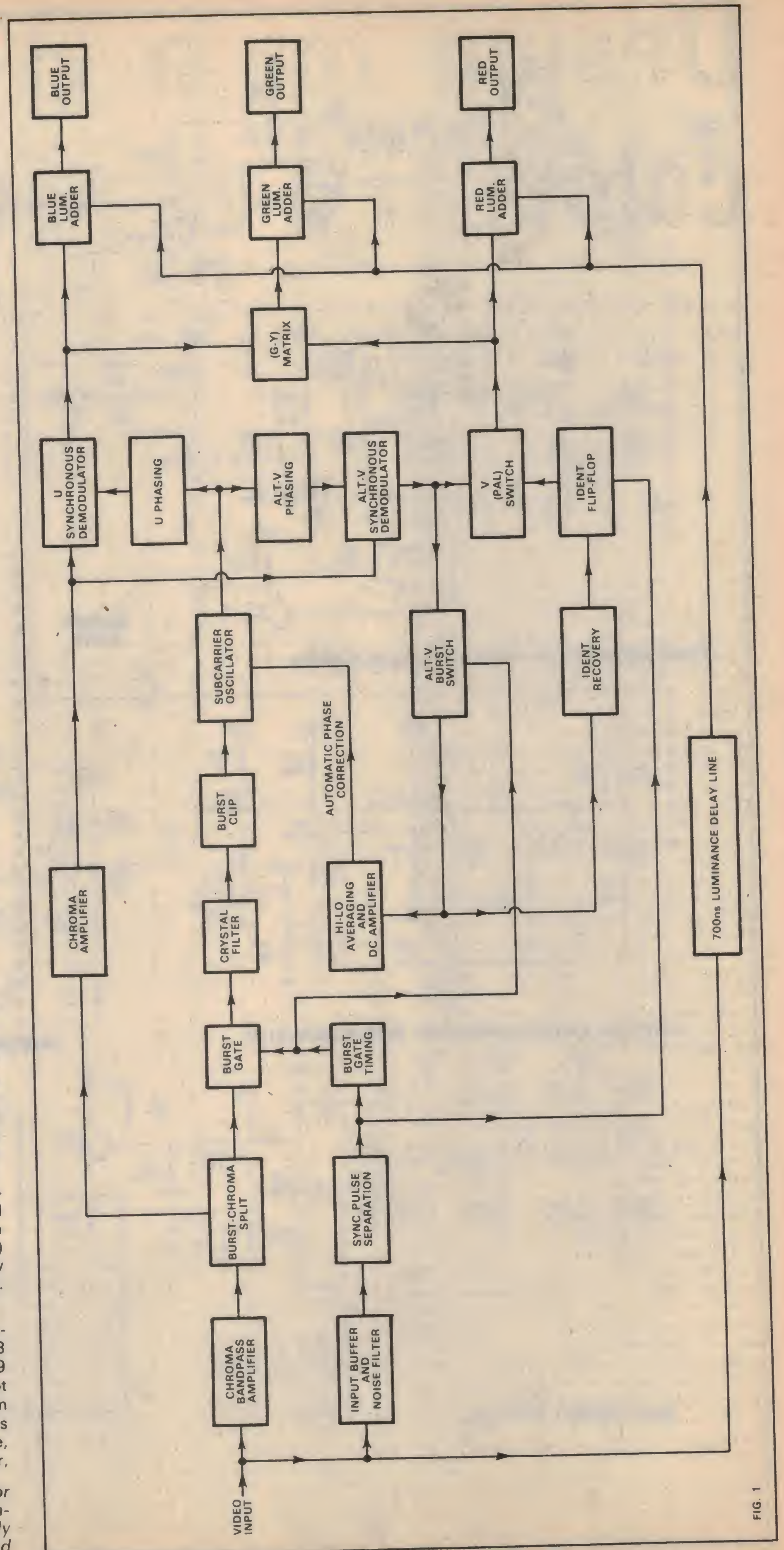
BURST GATING PULSE GENERATOR

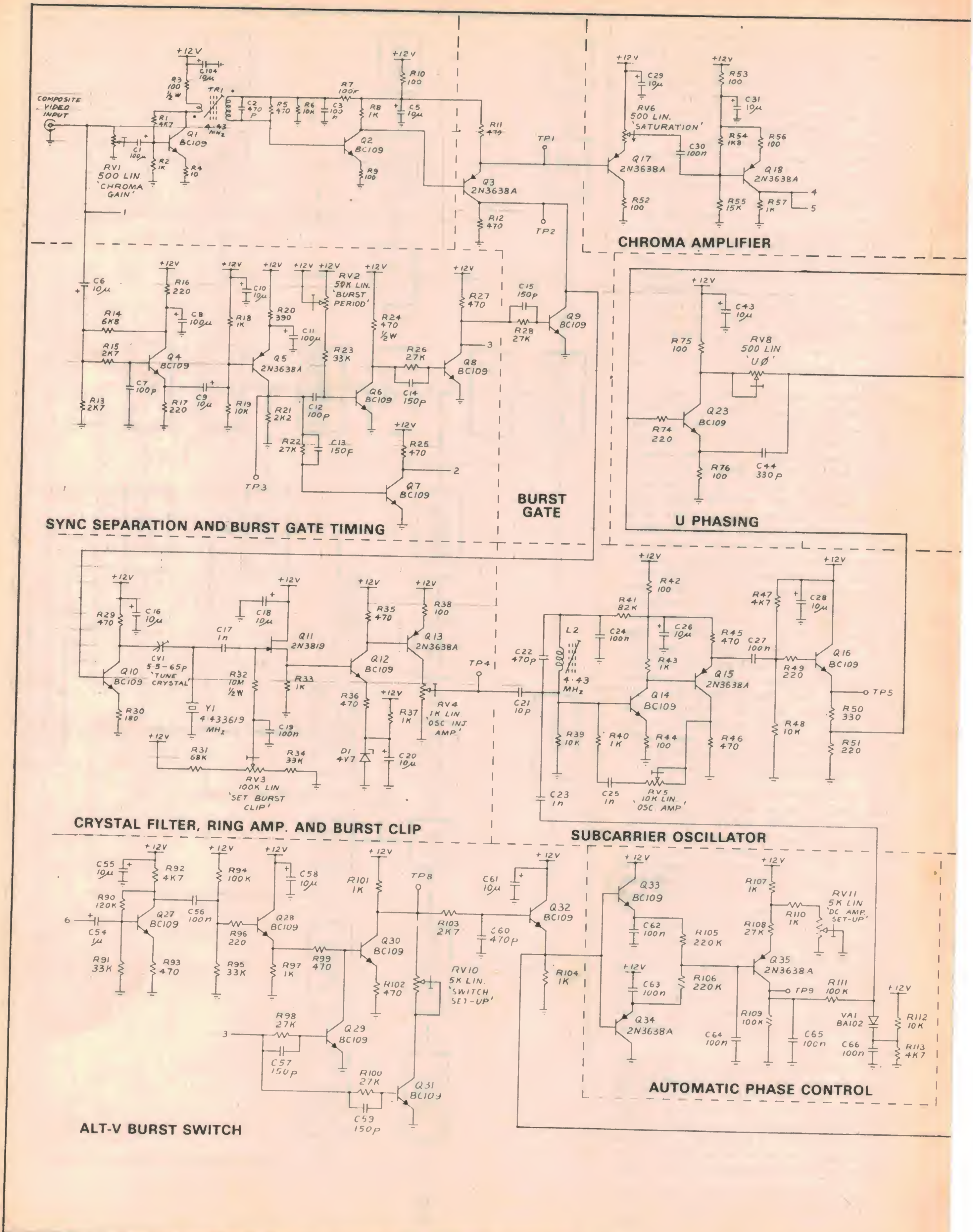
Because a pulse is required for both the normal burst gate and the ALT-V burst switch, the gating pulse generator Q6-Q8 is employed. Q6 is maintained in a conducting state by RV2 and R23. The trailing (negative) edge of the separated line sync pulse from Q5 is differentiated via C12, and turns Q6 off for 3.6uS following the end of the line sync pulse. The amount of differentiation, and hence the Q5 'off' time, is made variable by means of RV2, so that the gate period may be correctly adjusted. Because the base of Q8 is connected to the collector of Q6 via R26 and C14, when Q6 is turned 'off' (i.e. during the burst period) Q8 is turned 'on', so producing a low impedance negative-going pulse at its collector.

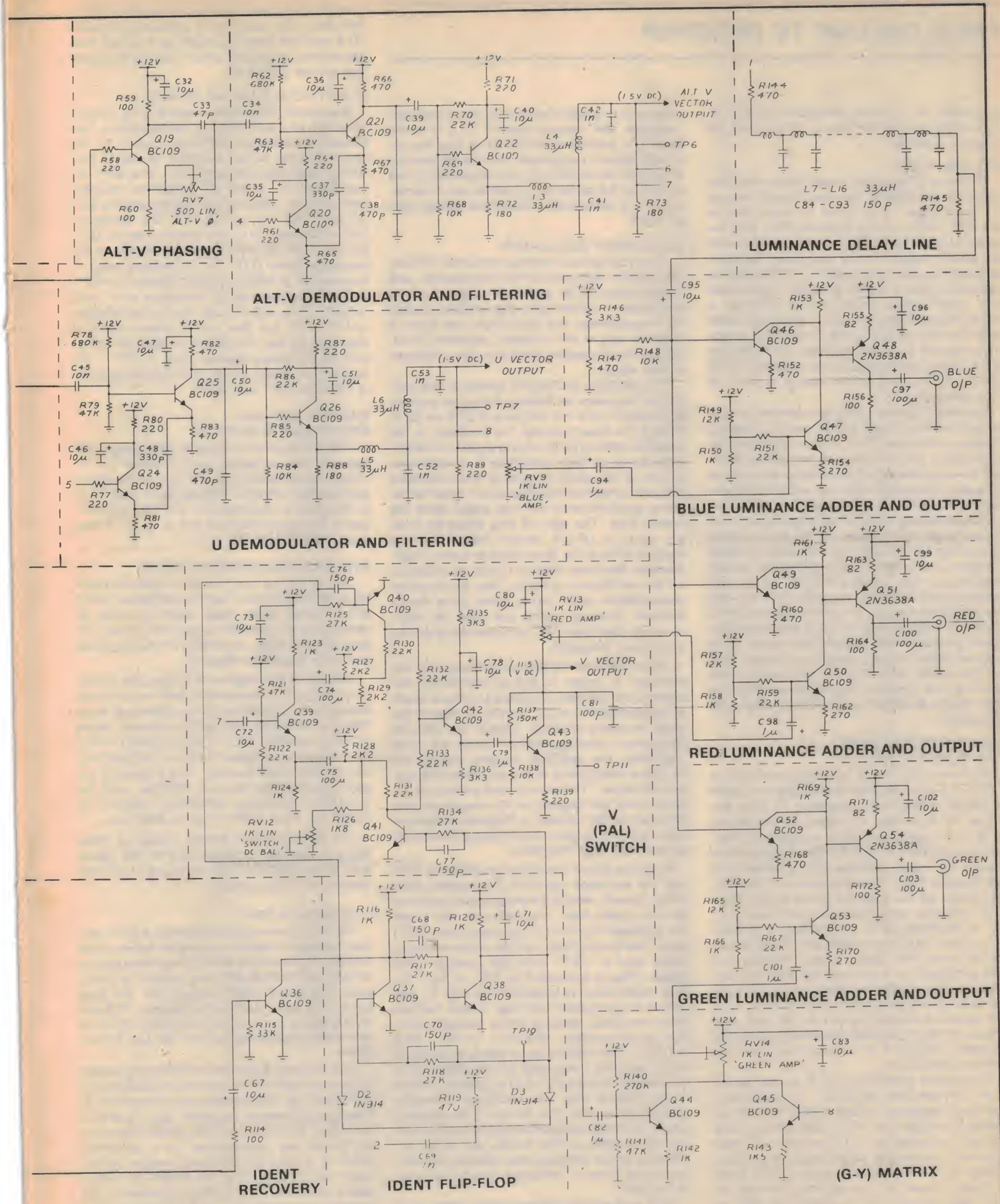
BURST GATE

The waveform at the collector of Q8 is coupled to the base of Q9 via the components R28 and C15. The result of this action is that Q9 grounds the collector of Q3 at all times, except during the burst period. The resulting waveform is illustrated in Fig. 4. The burst amplitude is adjusted by RV1 to be 1V p-p. In the meantime, Q3 continues to function as an emitter follower,

Fig. 1 (at right) shows the block diagram for the Mk II colour recovery system. The complete circuit diagram is shown overleaf. Readily available discrete components are used throughout.




COMPOSITE VIDEO INPUT
RV1 500 LIN. 'CHROMA GAIN'
CHROMA AMPLIFIER
RV6 500 LIN. 'SATURATION'
SYNC SEPARATION AND BURST GATE TIMING
RV2 50K LIN. 'BURST PERIOD'
BURST GATE
U PHASING
RV8 500 LIN 'UØ'
CRYSTAL FILTER, RING AMP. AND BURST CLIP
CV1 5.5-65p 'TUNE CRYSTAL'
Y1 4.433619 MHz
RV3 100K LIN 'SET BURST CLIP'
RV4 1K LIN. 'OSC INJ. AMP'
SUBCARRIER OSCILLATOR
RV5 10K LIN 'OSC AMP'
ALT-V BURST SWITCH
RV10 5K LIN 'SWITCH SET-UP'
AUTOMATIC PHASE CONTROL
RV11 5K LIN 'DC AMP. SET-UP'



PAL-S COLOUR RECOVERY SYSTEM
(MK. 2 DECODER)

producing the chroma waveform in Fig. 3. Again, the burst amplitude is 1V p-p, but the phase is inverted.

CRYSTAL FILTER

Q10 is a DC coupled crystal driver amplifier which is identical to the circuit given in part 1. The crystal Y1 is tuned to resonance at 4.433619MHz by the trimmer CV1, and because of its very high Q, continues to ring with an almost undiminished amplitude between excitation by each burst (see Fig. 2). The crystal resonant circuit is unable to follow the alternate line ±45° phase shifts, and so takes up a nominal operating phase of 0°. However, static phase shifts inherent in the crystal filter operation produce an absolute phase shift between the nominal burst phase at the collector of Q3 (TP2) and the ring at the source of Q11 of approximately 95°.

Additional phase shifts are present in the subcarrier oscillator, ALT-V and U phasing stages, chroma amplifier and synchronous demodulators. The directions of these phase shifts are so engineered that the relative axes of the chroma information and the subcarrier drive signals are correct at their respective ALT-V and U demodulators. With minor differences, these phase shifts are common to the first decoder circuit but for the sake of simplicity mention of them was omitted from the earlier circuit description. One important point which was perhaps over-simplified was that if the sub-carrier oscillator is to act as a synchronous demodulator and so produce unequal burst demodulation products, then the oscillator signal must have an offset from the mean burst phase. This will be obvious when Fig. 17 is consulted. Note also that the oscillator phase differed from the new design because no U phasing stage was employed.

FET SOURCE FOLLOWER AND BURST CLIPPER

As in the first circuit, a FET is employed as a high input impedance buffer stage in order to obtain a maximum operating Q from the crystal. In this case, the signal at the source of Q11 is directly coupled to a 2-stage non-inverting amplifier Q12-Q13. During the burst period, the mean potential at the collector of Q3 is about 2.9V. The crystal is shocked into oscillation by the alternate phase bursts from Q10. However, when the burst gate closes (i.e., Q9 is saturated) Q10 is deprived of forward bias, and so its collector returns to rail potential. At this time, the crystal is also ringing, and this oscillation is superimposed onto the rail voltage. Because the burst is disposed ±1.3V about 6.1V, and the ring is disposed about 12V, the two are separated by a 5.9V DC step, and the burst may be removed by arranging for the amplifier Q12-Q13 to conduct only on the positive excursions.

The emitter potential of Q12 is maintained at 4.7V by the zener diode, D1. Its base potential must therefore exceed 5.35V before the collector voltage can move downward. Since the gain provided by Q12 is unity, its base potential must exceed 6.0V before the collector voltage of Q13 can move upward. The burst is neatly clipped off by adjusting the bias on Q11 (and hence Q12) by means of RV3 so that just sufficient operating bias is supplied to handle the ring signal at the collector of Q13. The result of this operation can be seen in Fig. 2, although the ultimate adjustment is slightly different (see alignment procedure) so that increases in ring signal amplitude may be accommodated. The collector load of Q13 is in the form of a potentiometer (RV4) so that the oscillator injection amplitude may be adjusted to a standard value (500mV p-p) regardless of the activity of the particular crystal in use. If necessary, Q13 can provide a maximum voltage gain of 20dB.

SUBCARRIER OSCILLATOR

The synchronized oscillator circuit is virtually identical to that used in the first decoder, and a description of its operation is given in the text of part 1. Incidentally, this oscillator is ideal for experimental and instrument use since it requires only a two terminal resonant circuit, has adjustable feedback and provides a buffered output signal.

The oscillator is injection locked to the subcarrier frequency by feeding the signal present at the wiper RV4 into the base of Q14 via C21. During the burst periods, the oscillator is not supplied with a synchronizing signal. However, because of its high operating Q, it continues to run at the same frequency and maintains the same phase relationship which it had whilst being supplied with the ring signal from the crystal filter. The ratio of ring (sync) to burst (no sync) is 16.8:1, which means that the stability during the burst period is very high. Because the burst does not exert an influence on the oscillator's operation, the synchronous demodulators yield conventional burst demodulation products which are used for ident recovery, oscillator APC and assistance during the line-up procedure.

When the nominal free-run frequency of the oscillator is equal to the synchronizing frequency, the oscillator operates at a phase angle of approximately +30°, which is due to the input coupling network. When the free-run frequency is swung above or below the input frequency, the oscillator remains locked, but its phase relationship to the synchronizing signal will 'skew'. The amount and polarity of the phase skew will depend on the magnitude and direction of the oscillator's frequency displacement. When this becomes too great, the oscillator will lose lock altogether.

Since the phase inversions produced by Q10 and the oscillator transistor Q14 cancel each other, the sum total of the phase leads produced by the crystal filter (approximately 95°) and the oscillator input circuit (approximately 30°) mean that the oscillator operates with an output phase lead of 125° from the average burst phase. (This is equivalent to 55° of Fig. 17). This relationship is illustrated by Fig. 8, and should be compared with Figs. 6 and 7 which show the phase skewing limits available from the synchronized oscillator (+45° and +180°). The total phase variation available is 135°, and the magnitude of the phase shifts introduced by the ALT-V and U phasing stages is so chosen that the oscillator normally operates at or near the centre of its skewing range. This ensures optimum performance from the APC system, which makes use of the oscillator's phase skewing characteristic by controlling its free-run frequency via the varactor diode, VA1.

Q16 is an emitter follower stage, and is used to buffer the output of the oscillator from the input of the ALT-V and U phasing stages. Since the subcarrier drive required by the synchronous demodulators is 2V p-p, the necessary attenuation from the oscillator output level (5V p-p) is provided by the resistive divider R50-R51. DC coupling is employed between Q16 and both phasing stages, so that their bias conditions are actually determined by the resistive divider R47-R48.

U AND ALT-V PHASING STAGES

Because of phase shifts present in the chroma amplifier and synchronous demodulators, the subcarrier phase angles (with respect to the nominal burst phase) required by the U and ALT-V demodulators are 170° and 80° respectively, i.e., + and -45° from the oscillator output phase. These angles correspond to 10° (U) and 100° (V) on Fig. 17. The necessary shifts are provided by the phasing stages Q23 (U) and Q19 (ALT-V), which are driven by the oscillator buffer Q16. The U phasing stage is required to provide a phase advance of 45°, and its adjustment range is between +15° and +180°. The ALT-V stage must also produce a 45° shift, but this time a phase retard is required, so that the difference between the U and ALT-V demodulation axes is 90°. The adjustment range of the ALT-V phasing stage is between -10° and -80°.

CHROMA AMP AND DEMODULATOR BUFFERS

The path from the chroma splitting stage (Q3) through the saturation control buffer (Q17), chroma amplifier (Q18) and the synchronous demodulator chroma buffers (Q20 and Q24) is identical to that found in the first decoder, and a full description of this is given in the June 1974 issue.

SYNCHRONOUS DEMODULATORS

Similarly, the synchronous demodulators have not been altered, but the subcarrier filters which follow them have been increased in complexity to provide improved colour difference bandwidth, together with much greater sampling frequency rejection.

Instead of the original R-C low pass filters, two-section L-C types have been substituted. Since the Zo (characteristic impedance) of these filters is 180ohms, the emitter follower stages Q26 (U) and Q22 (ALT-V) are required to effect the necessary impedance transformations from the demodulator outputs. The f_c (cut-off frequency) of these filters is 880kHz, and the 4.43MHz sampling frequency rejection is 47dB, i.e. from 440mV p-p to 2mV p-p.

The formulae used for the design of these filters is identical to those used for the luminance delay line, and will be found in the text dealing with that section.

U DEMODULATION

The U synchronous demodulator is Q25, and the recovered U vector is available at the output of the filter. The wiper of RV9 provides a source of (B-Y) information which is variable in amplitude (the BLUE AMP. control) for the blue luminance adder and output stages. R89 and RV9 together make up the necessary 180 ohm terminating resistance for the filter L5-C52-L6-C53.

Figs. 15 and 16 provide an interesting insight into the operation of the synchronous demodulators, and are the collector waveforms with all filtering components removed. Fig. 15 shows the classic sampling operation when the swinging bursts are demodulated by a subcarrier which is shifted by 90° with respect to the mean burst phase. Fig. 16 shows the actual gating operation at 4.43MHz effected by the subcarrier signal at the base of the demodulator. The 'angle of flow' is approximately 130°.

The standard output signal from both demodulators is set by the saturation control (RV6) to be 100mV peak (U) or 200mV p-p (ALT-V) on the demodulated burst.

Fig. 2

Fig. 3

Fig. 4

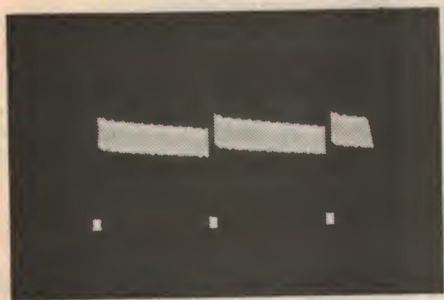


Fig. 5

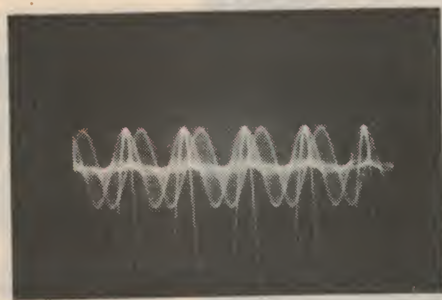


Fig. 6

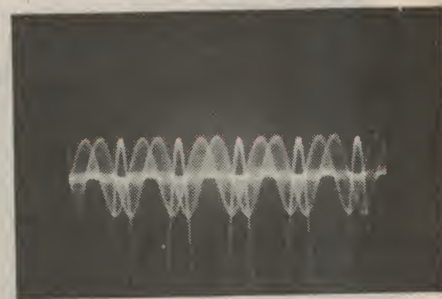


Fig. 7

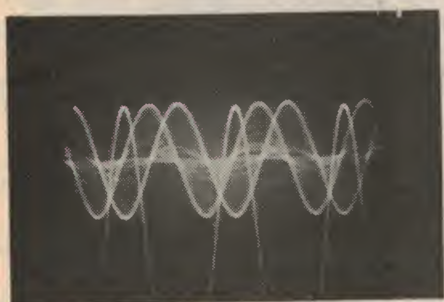


Fig. 8

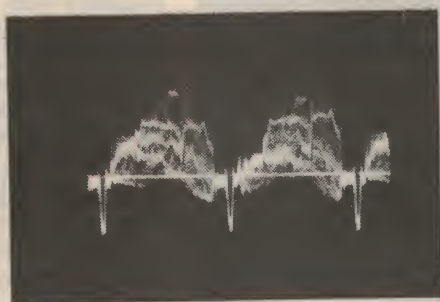


Fig. 9

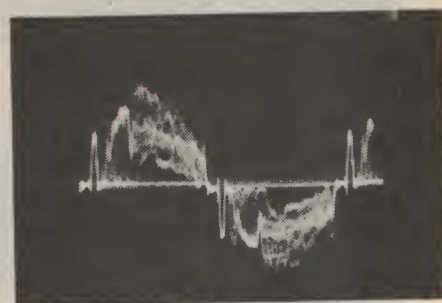


Fig. 10

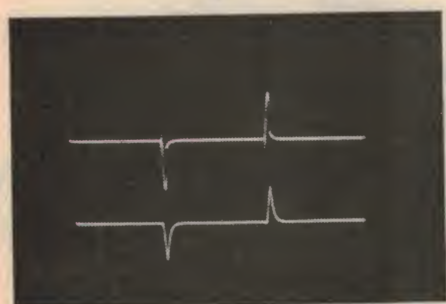


Fig. 11

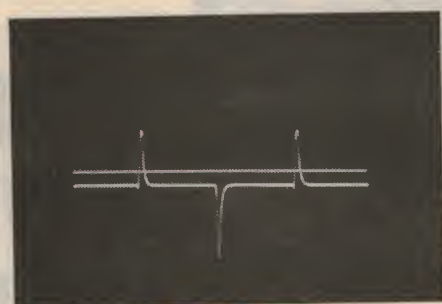


Fig. 12

Fig. 13

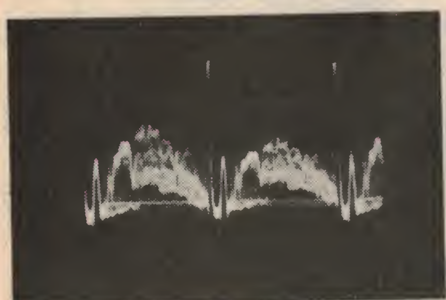


Fig. 14

Fig. 15

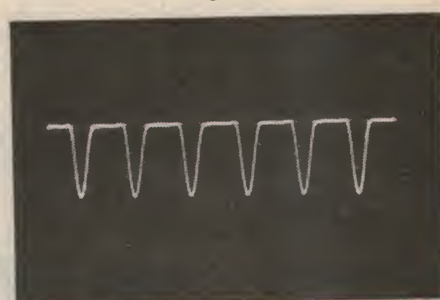


Fig. 16

Fig. 2: burst clipping action (see text) – Fig. 3: chroma at TP1; amplitude of burst = 1V p-p – Fig. 4: gated burst at TP2; burst amp = 1V p-p; burst gate period = 3.6uS – Fig. 5: signal at TP4 (see alignment procedure) – Fig. 6: oscillator phase skewing limit (+45° – see text) – Fig. 7: oscillator phase skewing limit (+180° – see text) – Fig. 8: oscillator phase normal (+125° – see text) – Fig. 9: U vector output (TP7); amplitude of demodulated bursts = –100mV pk – Fig. 10: ALT-V vector output (TP6); amplitude of demodulated bursts = +100mV pk – Fig. 11: ALT-V burst switch; output: top trace 3.25V p-p (TP8); bottom trace 2.5V p-p (after LP filter) – Fig. 12: ident recovery (at base of Q36); marker line is OV; amplitudes +0.7V, –1.55V – Fig. 13: ident signal at TP10; amplitude = 11V p-p – Fig. 14: V vector output (TP11); amplitude of demodulated and switched bursts = +100mV pk – Fig. 15: synchronous demodulator operation (see text) – Fig. 16: synchronous demodulator operation (see text). These oscillograms all taken from the author's Mk II decoder.

COLOUR TV RECEIVER

ALT-V DEMODULATION

For the V-signal recovery, the circuit techniques employed deviate sharply from those used in the first circuit. The chroma information is synchronously demodulated by a subcarrier on the V axis, but no alternate line phase switching is provided. Since the phase of the encoded V signal is changed by 180° on each alternate line, demodulation by a fixed phase subcarrier will produce a waveform in which each alternate line is reversed in phase (see Fig 10). This is known as an ALTERNATE-V signal. Whilst the polarity of the picture information is reversed from line to line, the +45° and —45° bursts also demodulate alternately positive and negative, as reference to the diagram in Fig. 17 will show.

If we pass the ALT-V signal through a switch which opens only during the burst period, the result is a series of pulses at line rate, each pulse having an alternate polarity. From this signal, two pieces of information may be gleaned. Firstly, since pulse polarity is directly related to burst phase, the ident may be recovered. Secondly, from the diagram in Fig. 17 we see that the amplitude ratio of the alternate line demodulated bursts depends on the subcarrier phase. The demodulated pulse amplitudes are only equal when the subcarrier phase is correct. This is the basis of the operating principle for the APC system, which detects a shift in the mean pulse level, and feeds a correction signal back to the subcarrier oscillator so that the phase returns to normal.

The V signal is reconstituted by inverting the phase of each alternate line of the ALT-V signal. A bistable multivibrator, guided by the ident information operates a switch which performs the polarity reversal. Because a wideband video switch usually cannot be produced as economically as one which has to handle only subcarrier or chroma information, post-demodulation PAL switching is generally not used in commercial decoders. However, because of the unusual signal paths employed in this decoder it was simpler to switch the ALT-V signal than to provide a separate switched-subcarrier V demodulator.

A great advantage inherent in post-demodulation V switching lies in its high phase accuracy. Phase shifts in a subcarrier or chroma switch will cause demodulation errors. However, when the same phase shifts are applied to the demodulated colour difference signal, they can only produce registration errors which are far too small to be noticeable. It is interesting to note that at least one high grade commercial colour monitor uses three demodulators: one each for the U, V and ALT-V signals.

The ALT-V synchronous demodulator is Q21, with the recovered ALT-V vector being available at the output of the filter L3-C41-L4-C42. This point is also fed to the ALT-V burst switch and the V switch.

ALT-V BURST SWITCH

The function of this stage is to remove the demodulated chroma from the ALT-V signal, so that only the demodulated bursts remain. Heart of the switch is Q30, which is connected as a common-emitter amplifier stage with a voltage gain of 6dB. Operating bias is supplied from the resistive divider chain R94-R95 via the emitter follower stage Q28 and the series resistor R99. When Q29 and Q31 are in the 'off' state, the operating conditions are such that the DC potential at the collector of Q30 is approximately 8.6V. Any signal which is AC coupled to the base of Q28 via C56 will therefore appear (inverted and 6dB up) at the collector of Q30. This is the case during the burst period, but at all other times Q29 and Q31 are kept saturated. The immediate effect of grounding the base of Q30 is to remove both the bias and the signal, thus allowing its collector to rise to +12V. However, since Q31 is also saturated, a variable resistive potential divider is formed from R101 and RV10. The value of RV10 is adjusted so that the collector potential during the switch 'off' time is equal to the potential determined by R94 and R95 during the 'on' time.

In the interests of stability, it is desirable that the DC gain of Q30 be kept low, and that the signal amplitude applied to its base be relatively high. Accordingly, the 20dB amplifier stage Q27 has been inserted between the ALT-V demodulator output and the switch input.

The switched burst output can be seen in Fig. 11 (top trace). In order to minimise the effects of noise on ident recovery, the switched bursts are fed through a low-pass R-C filter R103-C60. The —6dB frequency of this network is 125kHz. An emitter follower Q32 is used to buffer the filter output from the remaining circuitry.

Fig. 17: this diagram illustrates in practical terms what happens when the ±45° swinging burst is synchronously demodulated by a variable phase subcarrier signal as represented by the moving arrow.

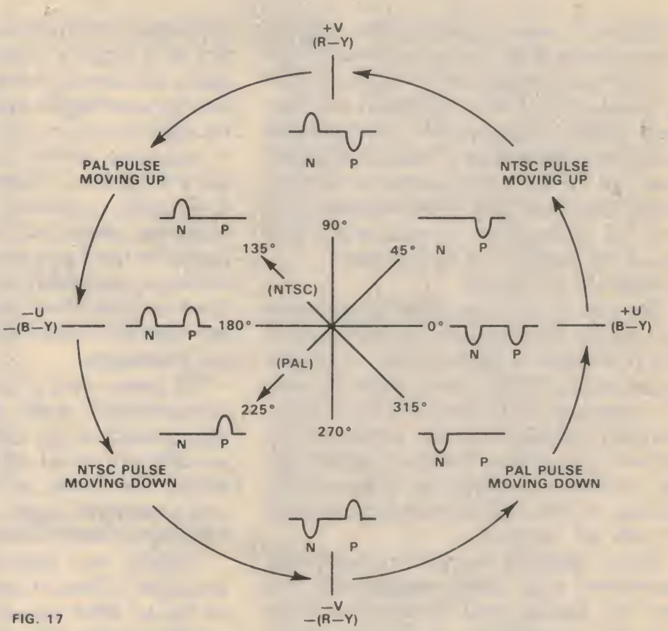


FIG. 17

APC SYSTEM

In the decoder circuit described so far, there are two main sources of possible subcarrier phase errors. The first of these is a drift in the free-run frequency of the subcarrier oscillator, as this will result in the subcarrier phase being incorrect. The second source of error stems from the action of the crystal filter, and this disadvantage is common to all passive subcarrier regeneration circuits. The crystal behaves as a very high Q tuned circuit, and as such is phase sensitive. A phase shift of 90° will occur when the input frequency moves away from the circuit's resonant frequency by an amount equal to its —3dB bandwidth. If the subcarrier frequency is maintained within specification at 4.43361875MHz ±5Hz, the phase shifts from this source will be very minor.

The function of the automatic phase control system is firstly to determine if the phase of the subcarrier signal supplied to the synchronous demodulators is correct. If errors are detected, a signal is developed and this is fed back to the subcarrier oscillator in order to correct its phase.

In this case, the demodulated ALT-V signal is used as the source of APC voltage. From Fig. 17, it can be seen that demodulation along the 90° axis with a CW subcarrier yields an ALT-V signal, in which the demodulated burst swings alternately positive and negative on successive lines. Furthermore, it can be seen that when the phase is correct, the positive and negative swings are equal. The ALT-V burst switch is used to gate out all other information except the demodulated bursts, and the result is averaged. If phase errors should occur, the alternate polarity demodulated burst from successive lines are no longer equal in amplitude, and will be predominantly positive or negative, depending on the direction of the error. The averaged output voltage will follow this change, and after DC amplification is applied to the subcarrier oscillator's frequency control circuit.

From the description of the subcarrier oscillator we have seen that when the oscillator is locked to the ring signal from the crystal filter, a change in the nominal free-run frequency will result in a 'phase skew' between the input and output signals. This characteristic is exploited for the APC system. Phase errors are detected in the demodulated ALT-V signal, amplified, and then applied to the phase skewing circuit in such a manner that the original error is cancelled. In other words, the circuit is constantly 'seeking' to balance itself about the point where the ALT-V demodulation is symmetrical. A high order of overall stability is achieved, because the APC loop covers the entire ALT-V demodulation process. The U demodulator is individually phased by means of a very stable phase shifting stage (Q23), so that correct U demodulation can be achieved.

It may be noted that when the oscillator is off-lock, there are two influences tending to produce synchronism. These are firstly the basic injection locking process, and secondly the asymmetrical beat products from the APC system. In a conventional phase-locked loop, only the second influence is available for initial lock acquisition.

(To be continued)

Forum

Conducted by Neville Williams

Should Australia have a full-scale Citizens Band?

A subject likely to generate heat in certain circles is whether or not Australia should have citizens band radio on the American pattern. Argument becomes all the more pointed because the main contender groups—the "forers", the "againsters" and the "statusquoers" can all make out a convincing case.

Attention was drawn to the subject earlier this year by a convention in Churchill, Victoria, organised by a group calling themselves "The Australian Citizens Band Radio Movement". Background material was distributed to the media and coverage for their case extended to television interviews and demonstrations. It fired the enthusiasm of supporters and stirred the hackles of opponents.

What's it all about?

The idea of private, short-range radio transceivers flowed naturally from World War II, where "walkie-talkies" emerged as part of the battle scene. After the war, the American FCC (Federal Communications Commission) was pressured to allocate a frequency band on which private citizens could operate transceivers, without all the inhibitions which applied to "official" services.

Those agitating for such a provision maintained that many citizens did not have the background or the inclination to secure an amateur style operator's licence; nor did they want to experiment with equipment, talk technicalities, or communicate across the nation or across the world. They just wanted to use radio as a casual, personal and essentially local extension of their ability to communicate.

In 1947, the U.S. Congress acquiesced by making available a band of frequencies in the UHF region (460-470Mhz) for the "Citizens Band Radio Service".

Related regulations made it possible for any citizen of the United States, 18 years of age or over, to operate a radio transmitter/receiver, using equipment which had been approved for the purpose by the FCC.

While there seems to have been an early assumption that most of the messages passed would be of a brief, substantive nature between associated transceivers, the system did not obviously impose this as a condition. Applicants were required only to fill out a non-technical card which normally led to the issuing of a licence valid for 5 years. The applicant did not have to advance a reason for wanting to operate a transceiver; his right to do so was taken for granted.

A licence holder could communicate on a frequency sharing basis, for pleasure, utility or indirect profit. Implication of the last phrase was that the equipment might be used as a minor aid to ordinary business operations but it could not be used to generate revenue directly. Thus, the operator could not charge for handling messages.

CB users were expressly forbidden to "experiment" with type approved CB equipment, or to carry out extensions, modifications or adjustments, except within the limits of FCC specifications and under the supervision of a person holding a commercial operators licence.

Initially, two classes of licence were available: Class-A covering transmitters of up to 60W input, with a frequency stability within .02%; these could operate anywhere within the allocated band and with antennas subject only to building codes. Lower performance, class-B equipment, 5W maximum input and less stable oscillators, had to operate nominally at 465MHz into restricted antennas, and not drift more than 0.4%.

Subsequently, a third type of licence, class-C, was announced, intended primarily for remote control of models, garage doors, etc.

As matters transpired, use of the 460-470MHz band was inhibited by the cost and complexity of equipment and by the fact that signal coverage was limited to little more than an "optical' path. Following agitation, a proposal was advanced that part of the 11-metre amateur band be also allocated for CB use. This was implemented by the FCC during 1957-59 as a class-D licence, with 23 available channels, spaced 10kHz apart, between the band limits of 26.960 and 27.255MHz.

The response was immediate and overwhelming, with more than 50,000 licences issued within months of them becoming available. Class A and B stations were virtually rendered obsolete and the 460MHz band became largely the domain of class-C radio control.

By and large, the concept and conditions set down for the original class-A and class-B UHF citizens band were retained for class-D with the notable exception that the normal power limit was lowered to 5W. And because 27MHz had the potential for occasional ionospheric coverage, a ban was placed on contacts international or over distances greater than 150 miles.

Supporters of the 27MHz citizens band point to it as one of the success stories of the electronics industry, with licensees running into millions in the United States alone and an enormous turnover for equipment ranging from tiny hand-held transceivers to mobile and fixed installations. Most of these are privately owned but a very large number are operated by local utilities, small firms, business and professional men who find it more convenient to use CB equipment than face the expenditure and complications of an "official" 2-way radio installation.

But critics of the CB concept put an entirely different construction on the facts and figures. They see the huge number of CB users as posing an impossible administrative task. There is no way, they say, that the FCC or any other regulatory body can keep track of licensed and well-intentioned users, let alone the huge numbers who don't bother with a licence or who abuse their licence either in a "merely illegal" or a positively antisocial manner.

"Merely illegal" operation would include the addition of high power linear amplifiers to transmitters, high gain beams for DX, "experimenting" without technical supervision, and the ultimate operation of the equipment as unlicensed amateur station, totally removed from the local, personal CB concept. Apart from anything else, the existence of such high power stations, engaged in lengthy DX or "net" activities, denies the channels to legitimate users.

The anti-social transgressions, which have been highlighted from time to time, are quite ugly: the transmission of false, mischievous or defamatory matter, obscenities, etc; standover tactics to block channels used as a business aid; and the use of CB equipment by groups and gangs to "set up" victims or crimes.

String together enough of these abuses and they will seem to outweigh any possible good, the community being better off without a facility so democratic but so open to abuse!

In fact, there are plenty of administrations around the world that think this way and, during the past decade, there has been evidence that the American FCC itself tended to share the view.

Opponents have often claimed that, if the FCC had its time over again, it would have vigorously resisted the proposals.

Initially, authorities in Australia took the hard line, affecting not to know the citizens band, or to recognise the existence of CB equipment. The importation or possession of transmitters for anything but the official allocations was effectively "discouraged".

The writer challenged this whole attitude in an editorial and a 3-page article in our August 1961 issue.

At the time, "experimental" FM stations in the capital cities had just been silenced on the grounds that the VHF FM band was needed for television and for additional communication channels.

We maintained that this was wrong thinking and that, with appropriate planning, FM broadcast stations and TV stations could share the 88-108MHz band. Further, that some of the pressure for two-way radio licences would be relieved if the authorities would take their heads out of the sand and encourage use of the citizens band and equipment being sold for it. We pointed out that applications in the USA were running at 12,000 per month, and that about 50 manufacturers were currently supplying equipment.

The articles produced an immediate response from readers and from industry, but scarcely a word from the authorities. Behind the scenes, however, it was evident that we had put a cat amongst the chickens.

In January, 1962, we were able to confirm that the PMG's Department, as the licensing authority, did have a frequency allocation around 27MHz for what they were choosing to call the "industrial" band. They had been remarkably reticent about it but were prepared to issue licences for operation in the band to people who had a "legitimate" need.

An interview with a Departmental representative at the time indicated typical "legitimate" users: bushwalkers; cave explorers; pasturalists; TV antenna jobbers; tug to dredge; boat to boat at sea (not boat to shore); sporting fixtures (officials only); medicos, surgery to vehicle; construction and maintenance work. There would be other possibilities but a basic consideration was that there must be no conflict with revenue-producing facilities, where available, already provided by the PMG or OTC. The frequency normally available was 27.24MHz and the power limit 1W ERP.

Applications for a licence involved the applicant's full name and address, an explanation of the business or activity with which the "fieldphone" would be associated, how and where it would be used, the number of fieldphones likely to be involved and the maximum likely communication distance; finally the precise brand and model of the equipment(s) to be used. The cost of a licence: one pound (or $2).

Since then, a considerable number of "industrial" band licences have been issued in Australia. Figures released in March 1974 indicated that about 20,000 hand-held transceivers had been licensed for "handphone mobile services", plus a number of special 5-watt "base stations. The gross figure now would be much higher.

A statement by the Postmaster-General indicates that the "CB" units are being used by private individuals and groups as indicated earlier, and also by utilities and departments for secondary communication links: police, fire brigades, forestry, civil defence. And, because the channels are not loaded up with trivial matter, those who have a legitimate need are better served.

The statement concludes with a reminder of a "long-standing Government policy in Australia that the public telephone and telegraph systems, which have been provided at considerable public expense, should be the normal means of communication between individuals residing in areas where these services are available".

A letter on behalf of the Australian Citizens Band Radio Movement brands the Postmaster-General's statement as "ridiculous". However one may disagree with it, I don't think it is. As I said at the outset, it is possible to advance sound argument in favour of the present Australian approach: namely to make communication facilities available to those who have an even modest need, and to exclude those who don't.

If anything is ridiculous in the Australian approach, it is the failure of other governmental bodies to help make it work. The simple fact is that people can bring into the country, or import and sell any number of citizen's band transceivers, ranging from highly developed units to junk. The stage has even been reached where they are given to children as birthday toys.

Officially, the vendors should seek type approval and warn the purchasers that a licence is required; and they should supply the PMG's Department with names and addresses of purchasers. But the simple fact is that it doesn't work this way and, alongside the 20,000 odd licensed units, we have a huge number of unlicensed transceivers.

It is intriguing to note that CB exports to Australia from Japan alone were more than 7,000 units in 1973, and 16,000-plus in 1974. As we observed in an earlier issue, we are rapidly acquiring a full-scale citizens band in Australia—by default!

The case for a communications band freely open to all rests partly on the concept that denial of access to anyone is a denial of their basic right. A motorist has to conform to all kinds of laws but thus far, as a nation, we have not questioned his right to be a motorist!

Should the CB facility become overcrowded or difficult to administer, the protagonists say, it is a problem to be solved, as such. In any case, they contend, CB tends to be self-levelling and self-correcting, with people using the channels to the extent that they think is worthwhile. And abuses? They have to be faced up to, as do the abuses of any other right or activity.

The other main line argument is that, problems notwithstanding, a CB facility can serve the interests of individuals and communities in a thousand isolated ways, most of them too transient ever to be documented.

Overall, the case for a freely accessible citizen band can certainly be built up to convincing proportions and it was the one accepted by the New Zealand Post Office back in the same 1961 era.

Whether New Zealand can be accepted as an example of a freely accessible CB situation is another matter. Severe exchange and import controls in the intervening years must surely have inhibited use of the band, and therefore the emergence of the "chaos" which is allegedly characteristic of American CB.

Curiously enough, there is some hint of a new and positive attitude to CB by the American FCC. Writing in "Popular Electronics" columnist Len Buckwalter says: "Unlike FCC documents of past years, which attacked CB as radio's black sheep, this one (No. 20120) is cause for celebration. It could more than triple the number of CB channels and ease the complaints about CB from the lawmakers."

The new proposals would extend the existing band to include 30 channels 10kHz apart between 26.960 and 27.310MHz. There is some debate as to whether the channels would be retained for AM operation only or opened up for some SSB equipment. Also under consideration is revised allocation of channels: calling only, emergency only, intra (same callsign) and inter (different callsigns).

A further extension of the present band—out to 27.505MHz—would accommodate 40 SSB channels at 5kHz spacing.

FCC docket no 19759 envisages a yet further expansion into a class-E licence, for operation in a band 222-224MHz.

This improved "accommodation", together with vigorous industry co-operation to stamp out the sale of illegal equipment, could go a long way to cleaning up the American CB scene.

Out of all this, one thing is patently clear about the Australian situation: we must put a stop to the present drift towards CB by default, or we will indeed end up in a mess. If we are to have a restricted situation, then government instrumentalities must co-operate to ensure that it is preserved. But if this co-operation is impractical, then the Radio Branch of the PMG Department should be empowered and equipped to turn what is almost a fait accompli into a properly supervised citizens band radio service, with channels, callsigns, co-operative regulations . . . the whole bit!

Using the Philips 10GHz Doppler module

Until recently, microwave radar systems and the range of applications they encompass have been relatively unavailable to the home constructor. This problem has now been overcome by the release of the CL8960 Doppler radar module by Philips Elcoma. In order to illustrate one possible area of application, Philips Elcoma built up a demonstration intruder alarm system, as described in this article.

by PHILIP TRACY*

Modern microwave radar modules such as the Philips CL8960 are based on a phenomenon known as the Gunn effect, an effect which causes a suitable semiconductor material to act as a microwave oscillator when operated under certain conditions. Costing far less than an equivalent klystron source, the Gunn oscillator, because of its inherent efficiency, reliability and compact size, is finding wide application in contactless object detection and observation equipment. Some of these applications include intruder detectors for security systems, aids for the blind, automobile anti-collision systems, contactless actuators, and speed and rotation measuring equipment.

Microwaves have many advantages over light, infrared and ultrasonic waves for such duties. Principal among these is the relatively unpolluted section of the spectrum in which they operate—few natural phenomena or electrical machines generate incidental microwaves. In addition, conventional radio signal processing techniques are available for extracting information from the signal.

While these radar systems are essentially very simple in theory, the production of workable systems has been confined to a limited number of companies possessing the necessary know-how and resources. The two main limitations to date have been:

- the difficulty in separating the wanted signal from power supply spikes, ripple etc in commercially available devices using a common Gunn oscillator/mixer diode;
- the lack of commercially available mechanical hardware for a Gunn oscillator/separate mixer diode type of system.

The release of the CL8960 twin transmitter-receiver radar module assembly by Philips Elcoma is intended to overcome these problems and, by eliminating the need for microwave test equipment, to increase the number and range of potential users of microwave systems.

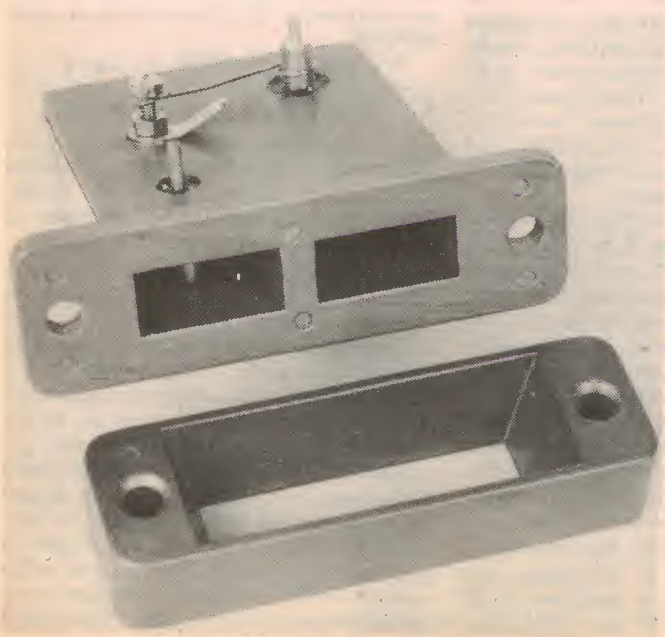
For those readers unfamiliar with the operation of Gunn devices, a brief theoretical discussion follows.

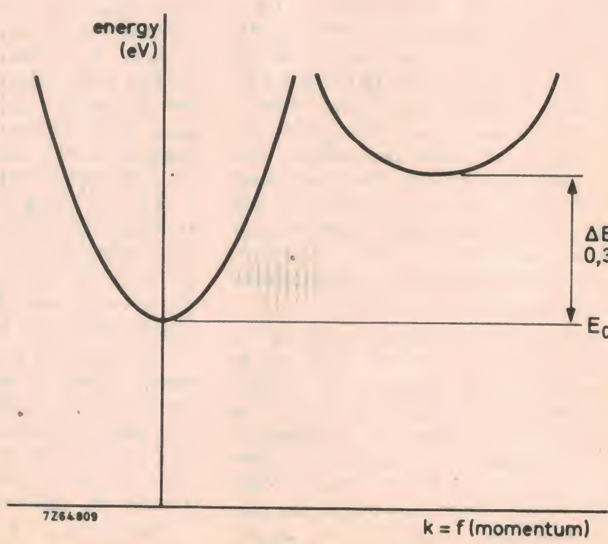
The Gunn effect was discovered in 1963 when J. B. Gunn first reported that he had obtained coherent oscillations by applying an electric field to a crystal of gallium arsenide. A power output of 0.5W at 1GHz was quoted for these early experiments. Since that time, a great deal of research and development effort has been devoted in producing a range of microwave generators with stable predictable properties.

Basically, a Gunn device consists of a sample of bulk semiconductor, moderately but uniformly doped, provided with ohmic contacts, and mounted in a suitable cavity. Under suitable pulse or DC bias conditions, the device will act as a microwave oscillator.

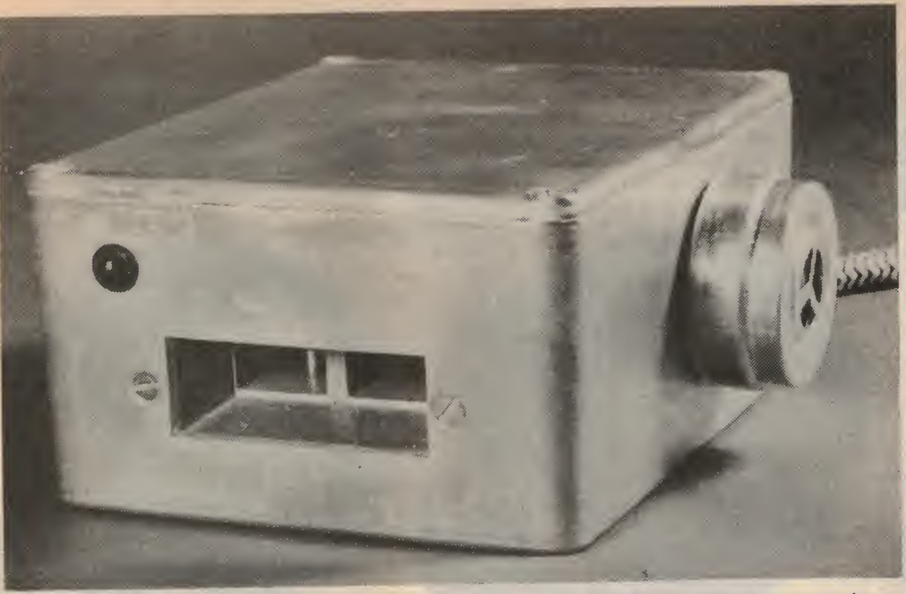
The effect may be explained in terms of the conduction mechanisms found in certain types of semiconductor compounds. Studies have revealed that the momentum of an electron travelling through a solid may only have certain

*Product engineer with Elcoma, Division of Philips Industries Holdings Ltd.





At left is the Philips CL8960 X-band Doppler radar module, together with its 5dB gain antenna horn. Fig. 1 (above) depicts the energy band diagram of gallium arsenide.



Use of the CL8960 radar module in a practical situation—the demonstration microwave intruder alarm as built up by Philips Elcoma.

discrete values, which depend on the material itself. When an electron gains sufficient energy, its momentum may change from a low value to a higher value. A change in momentum corresponds to a change in effective mass and a change in mobility.

If the range of energies available to an electron in a particular solid is plotted against the wave vector *k* (where *k* = *2(pi)ph, p* being the momentum and *h* Planck's constant) the resulting graph is called the energy band diagram for the material. The energy band diagram of gallium arsenide, the material used for the majority of Gunn devices, is shown in Fig. 1.

For electrons having energy of only a little more than E_0, only the valley corresponding to the lower conduction band is available. If a sufficiently large electric field is applied across the material, some electrons will acquire sufficient energy $(E_0 + \Delta E)$ to allow them to attain the upper conduction band. Since here their effective mass is much higher, and mobility appreciably lower, electrons reaching this band will slow down. Thus with increasing applied voltage electron velocity, and therefore current density, decreases, and the material exhibits "negative" resistance.

When a sample of gallium arsenide is biased to beyond its Gunn effect threshold of 3,500V/cm, electrons in the cathode region will enter the upper energy band, the current density will fall, and the electric field across the specimen will be concentrated into a "domain" in the vicinity of the high energy electrons. Since these electrons will be moved across the specimen by the remainder of the field, the domain will migrate at a characteristic drift velocity of about 10^7cm/sec.

When the domain arrives at the cathode it will collapse, causing the field strength across the specimen to once again exceed the critical level, and thus form a new domain at the cathode. The current through the specimen under these conditions thus consists of a quiescent DC current with a series of pulses superimposed on it. The frequency of these pulses varies inversely with the time taken for the individual domains to traverse a given specimen. With a drift velocity of about 10^7cm/sec, this corresponds to about 10GHz for a sample about 10um thick.

The receiving section of a Gunn microwave device consists of either a separate diode mixer, or a combined Gunn effect/mixer oscillator diode. The former type offers superior signal-to-noise ratio performance.

The Gunn diode can be made to oscillate in waveguide, coaxial or microstrip circuits by means of a resonator and DC power supplied through a low pass filter. The condition for oscillation is that the circuit impedance vanishes. A Gunn oscillator thus consists of a Gunn diode, of given "negative" resistance, together with a positive resistance of the same value.

The Philips CL8960 radar module used in the intruder alarm described here is of the separate Gunn oscillator/diode mixer type. Designed to operate at the X-band frequency of 10.687GHz, the CL8960 is supplied complete with a detachable 5dB gain antenna and costs around $28.00 plus sales tax. Individual devices should be ordered direct from your regular supplier of Philips Elcoma components.

The transmitting section consists of a Gunn diode from the Philips CXY11 family mounted at a distance of one wavelength at the wanted transmit frequency (10.687GHz) away from the short circuited end of a tuned microwave cavity or waveguide. This ensures that the diode is presented with a small amount of resistive impedance. Power output is typically 8mW when operated from a 7V DC supply.

In order to obtain a small range of frequency adjustment, a small screw is inserted about halfway along the cavity. Adjustment of this screw causes a change in the VSWR (voltage standing wave ratio) of the cavity thus changing the diode loading and causing a small change in operating frequency. This adjustment is preset during manufacture, and should not be tampered with.

The receiving section of the CL8690 consists of a Schottky diode from the BAV46 family. This device is mounted about ¼ wavelength from the short circuited end of a waveguide cavity similar to the transmit cavity. The transmitter and receiver waveguides are siamesed together and coupled to a common transmitting and receiving aerial.

As supplied, the CL8960 module comes with a shorting strap between the mixer AF output terminal and earth. The mixer has a low junction capacitance and may be damaged by transients of quite short duration. It is therefore recommended that soldering appliances be isolated from mains supplies and that the shorting strap be left in position until all wiring has been completed.

The microwave intruder alarm system operates on the principle that the reflected RF signal from a moving target undergoes a Doppler frequency shift. In fact, a double frequency shift is observed by the receiver since the target will move in respect to both the transmitter and receiver, which are fixed at a common location. This Doppler shift is a function of the transmit carrier frequency and the speed of the reflecting object. For normal X-band systems (carrier 10.687GHz), a target speed of 1 metre/sec results in a Doppler frequency shift of about 70Hz.

RF energy reflected from a target is fed to the mixer diode where it is mixed with a sample of the transmitted frequency to produce a direct audio output voltage. If the target is stationary, the phase relationship between these two signals will be constant, giving a constant DC output voltage from the mixer. However, the Doppler frequency shift produced by a moving target results in a varying phase relationship between the reflected RF signal and the sample frequency, causing the mixer to produce a varying output voltage signal or Doppler signal.

The way in which the Doppler signal is processed is very much dependent on the personal opinions of the various security companies, as a result of their experiences. The systems may include either analog processing (filtering, level detecting) or digital processing (digital filtering, counting the number of times a given frequency is observed), or a combination of both.

In order to understand the reasons behind the choice of signal processing,

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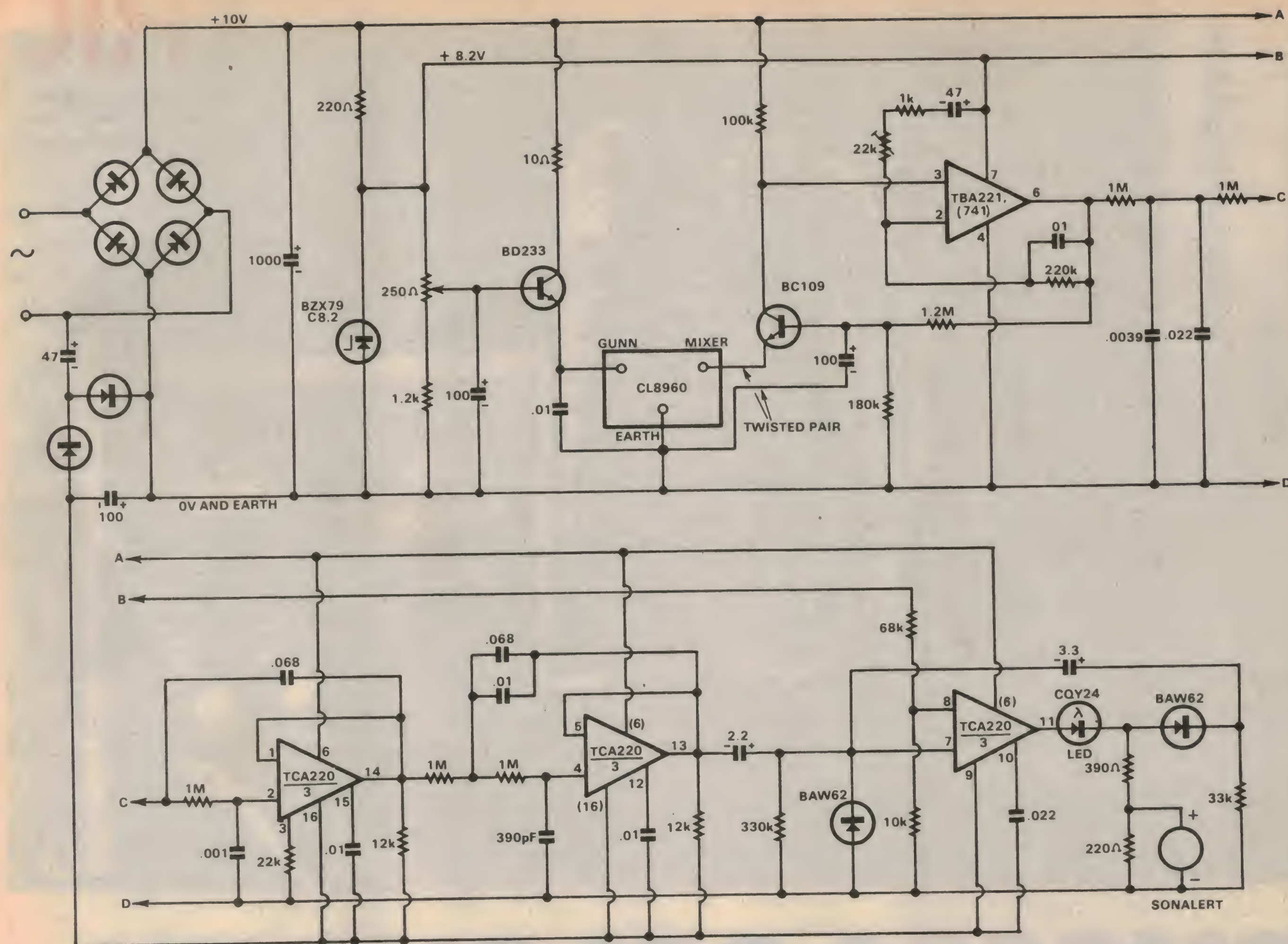


Fig. 2: the circuit diagram of the Philips Elcoma microwave intruder alarm.

it is worthwhile considering the environment in which a radar intruder detector will operate, and those signals which will indicate an intruder.

At first consideration, it would seem that the amplifier pass band should be centred on about 150Hz as this is the Doppler frequency generated by a medium walking pace of about 2 metres/sec (4MPH). However, when one looks more closely at the process of walking it is found that due to the hesitant movements of legs and arms, and swaying of the upper body, the actual Doppler spectrum is centred around 50Hz for a man walking slowly towards or away from the transmitter. This figure is reduced to around 10Hz for similar movement across the radar beam. In both cases, the frequency spectrum extends right down to a couple of Hertz.

Looking next at the sources of interference, one finds that the lower frequency limit is set by the 1/f noise generated in the mixer diode and preamplifier. Despite efforts to reduce this interference by special selection of mixer diodes to have low 1/f noise close to the carrier frequency (BAV46), and the use of low noise transistors (BC109), it has been found desirable to limit the low frequency response to about 5Hz.

Turning to the higher frequencies, the first major system problem occurs at 50Hz due to gas discharge lamps (fluorescent lights etc). Although their major effect is at 100Hz, due to asymmetrical conduction, they also cause 50Hz signals. Most practical intruder alarms contain circuitry to suppress 50Hz and 100Hz RF interference. Perhaps the simplest system is a low pass filter with a cut-off frequency below 50Hz. However, twin-T filters and complex digital filters are also in use.

It is also necessary to provide some means of controlling the range of a radar protection system, and the most common method is a simple gain control on the preamplifier. This method relies on the fact that the transmitted and reflected signals are each attenuated by 20dB for a 10 times increase in path length. A simple detector system also incorporates a level control to render it insensitive to small objects such as flying insects, etc.

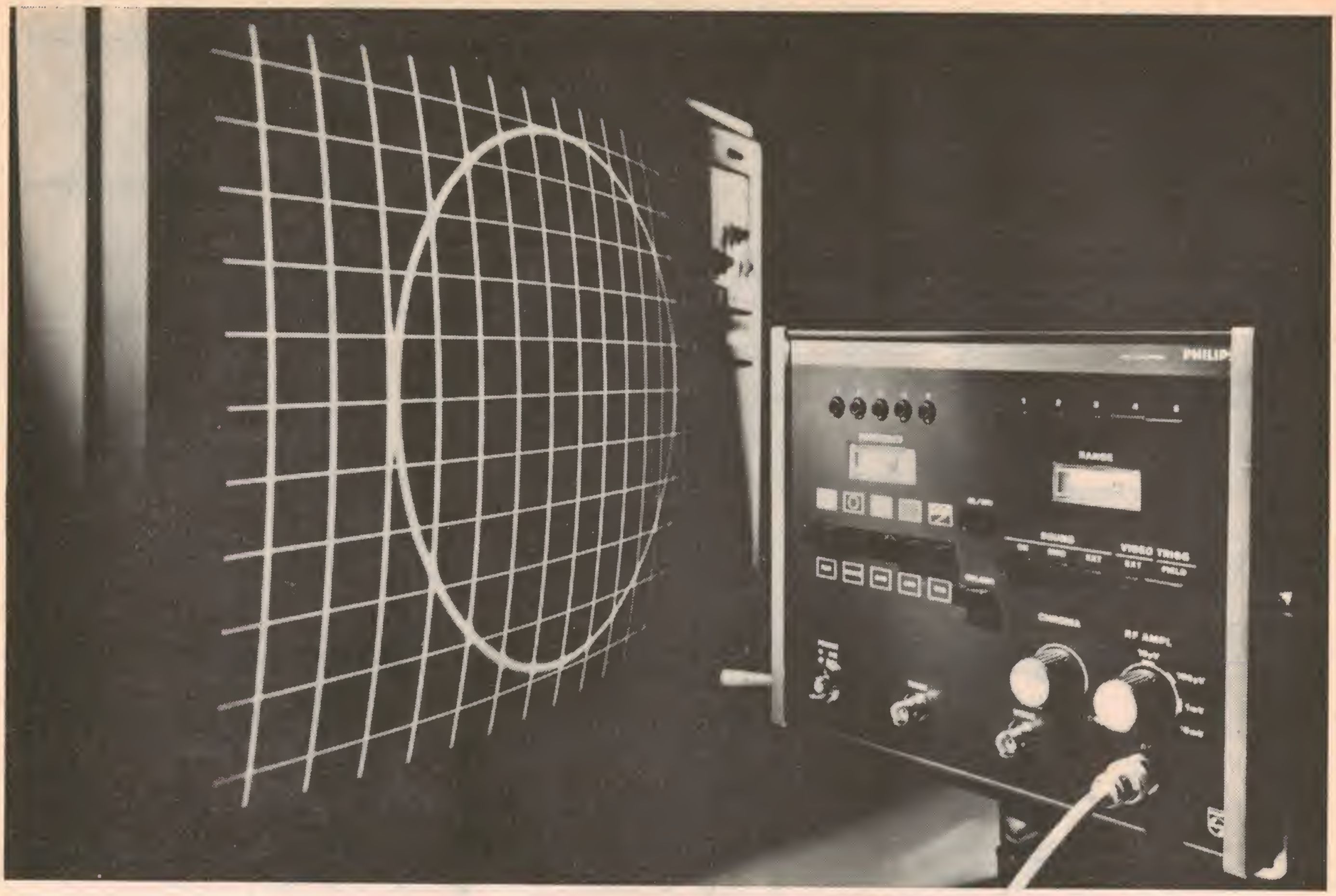
In order to illustrate just how effective simple signal processing techniques can be, Philips Elcoma built up a demonstration unit according to the circuit depicted in Fig. 2. This circuit contains the recommended Gunn diode feed circuit together with a very effective preamplifier, but has only low pass filtering plus level detection to initiate the alarm. Range control uses the simplest method, i.e., gain control.

As such, the design presented here was not originally intended as a practical proposition, although the prototype appears to function quite well within its design limitations. A practical intruder alarm device would probably require battery operation, and would certainly require a more effective alarm system than the Sonalert device used here. However, the basic circuitry is presented, and individual constructors are free to experiment along these lines. We turn now to the circuit details.

DC bias for the Gunn diode is obtained from a sample voltage regulator based on a zener reference diode. A 0.01uF capacitor is connected close to the +7V Gunn diode terminal and the earth terminal to suppress parasitic oscillations in the supply circuit.

A small amount of DC bias is also applied to the mixer diode, in order to increase its sensitivity as a mixer. The total bias under which the mixer operates is 42uA, which is the sum of the applied bias (35uA) and the bias from the coupled local oscillator supply (7uA).

Output from the mixer diode is fed into the emitter of a BC109 transistor



preamplifier stage operating in common base configuration and providing a gain of 100. This stage is direct coupled to a Philips TBA221 (equivalent to 741) operational amplifier, the gain of which can be varied from 10 to 200 times by means of a 22k trimpot.

From here the signal is fed to a fifth order Chebyshev low pass active filter (⅔ TCA220) with nominal unity gain in the pass band, 3dB attenuation at 25Hz, and 50dB attenuation at 50Hz. The filter values were taken from the design tables for the TCA220 triple operational amplifier.

The remaining amplifier in the TCA220 is used as a simple level detector with monostable action and a hold time of about 3 seconds. As shown in the circuit, this amplifier is used to drive a LED and a Sonalert alarm device.

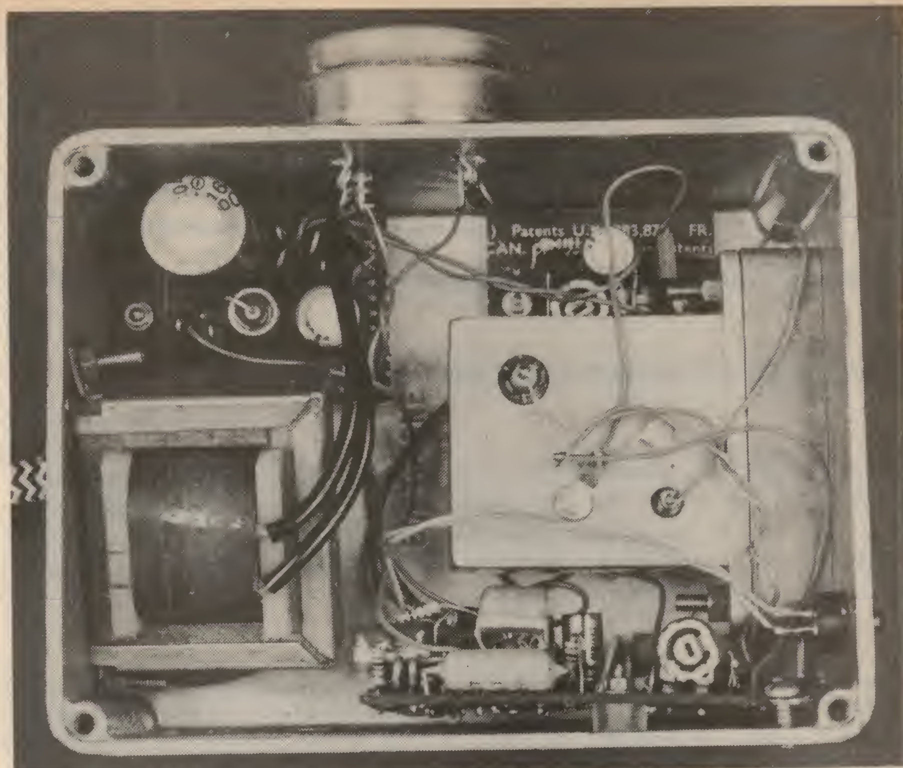
Because the demonstration unit is mains operated, a negative supply rail was included to simplify IC biasing. However, a practical unit would probably need to operate from a single 12V battery supply rail, and may need artificial centre point generation to bias the filter IC. Negative supply rail voltage in the demonstration unit is of the order of –10V.

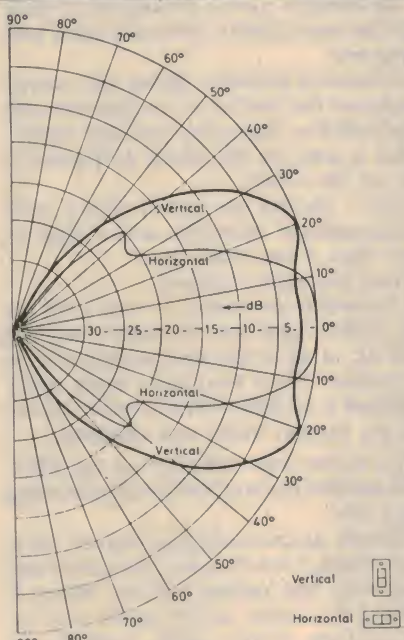
The prototype unit was constructed on Veroboard and mounted in a standard diecast metal case as pictured. Constructional details are left to individual constructors, as are the power supply details and any circuit modification required for a more practical alarm system.

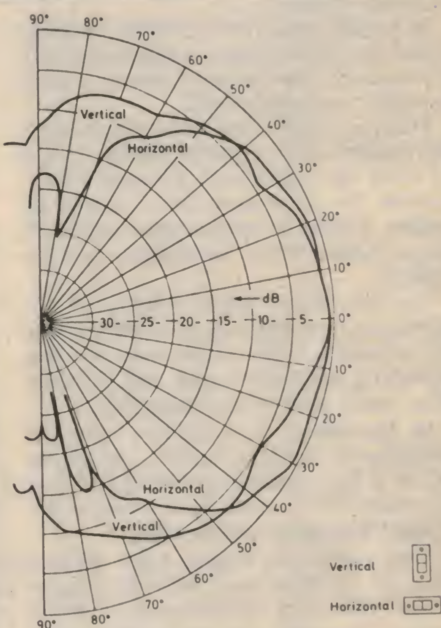
In practice, the demonstration unit has an adjustable range of between 2 and 9 metres, which agrees quite well with the theoretically calculated values. Greater range is best obtained by means of higher gain antennas, although this could also be achieved by increasing the amplifier gain. The theoretical range limit which gives a 20dB signal-to-noise ratio Doppler signal is around 15 metres when using the 5dB gain aerial supplied with the CL8960.

Designs are available for a 14dB gain antenna which provides an approximate three fold increase in range at the expense of a narrower beam angle. Beam dimensions are about 60 x 60° when using the 5dB antenna supplied, and about 50° x 24° when using a 14dB gain antenna. Polar diagrams of the free space radiation pattern for these two antennas are shown in Figs 3 & 4.

If, for environmental reasons, it is considered desirable to cover the antenna aperture, it is recommended that a thin plastic material (approximately 0.25 mm thick) be fixed to the metal plate with adhesive. Note however that this will result in an increase in the level of reference signal fed to the mixer from the Gunn diode, increasing the mixer bias current to approximately 60uA. The result will be an increase in AF output voltage for a given target, accompanied by a degradation in the signal-to-noise ratio. This should be acceptable for most applications.







At top is an interior view of the microwave intruder alarm. Fig. 3 (above left) and Fig. 4 (above right) are polar diagrams depicting the free space radiation patterns of the 14dB gain antenna and the 5dB gain antenna respectively.

The use of other materials in this role will only serve to further degrade the signal-to-noise ratio and upset the operating conditions of the module. Their use should therefore be strictly avoided.

The intruder alarm unit described in the preceding paragraphs is intended to illustrate just one possible area of application for the CL8960 radar module. As indicated in the introductory paragraphs, a range of other possible applications exists. To recapitulate briefly, these include speed measurement, range measurement, vibration measurement, and process control. Extension of the range measurement principle, to provide a measurement of range from two discrete modules appropriately located, can provide target location information.

However, it is beyond the scope of this article to give detailed design criteria for these application areas. Circuit details are left to those constructors possessing the necessary design experience.

The Serviceman

How to win friends—and lose money!

The ideal job for a serviceman is one which makes him look good, takes a minimum of time to complete and shows a tidy profit at the end. This month, by way of a diversion, I recount two situations which, between them, produced a red face, hours of talking and circuit tracing and not a cent of income!

The "red face" situation was a purely domestic one which will serve to demonstrate that your serviceman is a mere mortal, with a full share of human and technical frailties!

I had just settled down for the evening when Mrs. Serviceman remembered that her vacuum cleaner had come to a sudden halt that afternoon.

Frankly, I didn't find much pleasure in the request. Like most husbands, I have to work up enthusiasm for odd jobs—ponder the problems for a couple of weeks, waiting for an occasion when I'd rather potter in the workshop than go visiting!

The last thing I felt like doing on the particular evening was to methodically collect all the necessary tools to take the offending appliance apart and possibly finish up by almost reconditioning it.

So I grabbed the only two items of servicing equipment I could see within reach: a high resistance multimeter and a screwdriver. Everything else was in the "shop", locked up for the night.

Thus equipped, I turned the cleaner over on its back and, with the screwdriver, removed the bottom cover to expose the wiring and the foot-operated on-off switch.

I plugged the cleaner into the power point, turned it on and reached for the multimeter. Flicking around to the high voltage AC range, I measured across the incoming mains leads, which terminated at an insulating block. To my disappointment I got a quarter-scale reading—250V on the 1000V AC range.

Curses! I had hoped that the trouble would simply be an open power lead.

Next step was to check at the foot-operated switch. On one side I could measure volts; on the other side there were none, no matter how many times I operated the switch.

Curses again! I was faced with a faulty switch, which I couldn't replace on the spot because it was a special type.

Just to make sure of things, I took one of the multimeter test leads and, using it as a jumper, bridged the contacts of the faulty switch.

The cleaner motor should have spun into life, but it didn't. What the heck was going on?

Somewhat dubious about my sanity, I replaced the lead in the multimeter and checked the incoming voltage again. There it was on the block and there it was on the switch.

Until I clicked the switch, that is, and it disappeared from the active side as well! Now I was really mad.

Then the cent dropped.

I looked at the meter. It wasn't set on the 1000V scale and it wasn't reading 250V AC at all. It had just happened that the pointer came to quarter-scale and I had read it as 250V without really thinking. My human frailty was showing.

The meter was really set on the 250V scale and the pointer had been indicating about 80V.

Silently acknowledging myself as a dumb cluck, I reached up and pulled the plug from the power socket. When I hooked the screw driver under one of the active leads and pulled, it "stretched", or at least the rubber insulation did. The wire was broken in the most obvious place, just as it looped into the power plug.

Why the 80VAC reading?

Simply because there was enough capacitive coupling across the break to provide the very small amount of current necessary to deflect the multimeter.

Remember that I said it was a high resistance type?

The meter showed a reading whilever there was nothing else across the flex. The moment I closed the footswitch and connected the motor across the flex, the voltage disappeared.

The moral is simple: Next time you have to check an appliance, do it properly. Either use a lower resistance voltmeter or disconnect the appliance from the mains together and trace things through by measuring continuity and resistance. I have yet to see a stray capacitive path big enough to trick a DC measurement!

Red face? Well, it was a private sensation. I must have looked every inch a professional as I prodded around inside the cleaner with a multimeter and a puzzled frown. Why admit that I could have done the job much faster if I'd simply used the screwdriver in the first place to check the plug!

Perhaps the second story makes up for it, in a way, because I was able to correct an obscure fault without ever laying a hand on the equipment concerned. But the episode was notable for the time it took, and its lack of financial yield!

It began when a friend bought an electronic organ, of which he was duly proud. I gather that it was a slightly ageing design, but a good one, and he felt that he had got more than his money's worth.

But, one day, he expressed to me the conviction that the bass pedals seemed to be losing some of their punch. He had to advance the pedal volume control more to get the same level and, in addition, the response of the pedals seemed to be "a bit sluggish". Could I pop in and have a look at it some time?

Frankly, I needed to "pop in and have a look" about as much as I needed the usual hole in the head. I could imagine that, by the time I had picked my way through the circuit, found out how it all worked and where it was located in the organ, and then tried to work out what might be wrong, it would have been time for next morning's breakfast!

So I didn't encourage the idea, and weeks went by with my friend still presumably unhappy with his bass pedals.

It must have been months later that he made the next relevant observation:

"Funny about that organ, but the bass seems okay again; just like it was when I bought the organ."

I gave a grateful grunt of satisfaction, though without too much conviction. I have been much too long in the electronics game to be easily convinced by faults that cure themselves.

And, sure enough, some months later, he was back on the old theme: the bass seemed down in level and sluggish, just as it had been on the previous occasion. Another "funny thing": he had noticed that it seemed normal enough at first switch-on, but deteriorated within the first few minutes of playing. It was a new piece of information and it gave me a possible clue.

I asked: "Does the organ use germanium transistors?"

"Transistors, yes. Germanium, I wouldn't know. Why do you ask?"

I explained that it could be a temperature effect, since germanium transistors in particular tend to change their characteristics with rising temperature.

And, as we chatted, we realised that he had bought the organ in the winter season. When he first noticed the loss of bass, it would almost certainly have been summer. Then it came right again—next winter—and now it was starting to misbehave as the warmer weather set in.

I felt quite proud of my powers of deduction, and even offered to have a look at the circuit and see whether I could pick out the offending stage.

At this point my friend suggested that the circuit might be "a bit complicated". He pointed out that, when you pressed a bass pedal, the organ played that note. But it had a "pedal sustain" system that would keep the note playing for a while after you took your foot off the pedal. But if you played another pedal shortly afterwards, it would cut the note that was being sustained, play the new note and sustain that!

Anyway next morning, over a cup of tea, I decided to take a quick look at the circuit, which he had dropped in.

Quick look indeed! There were multiple contacts to select notes, to bias transistors on, and bias transistors off; flip-flop frequency dividers, time constant circuits, and so on. You name it, it was there. Even the biasing arrangements of the transistors seemed completely crazy. So I gave it away until late that evening when Mrs Serviceman and the kids were safely in bed.

This circuit wasn't going to beat me if it took me till midnight to work it out. And it did just that!

Laboriously I figured out what would happen to this transistor and that as any given bass pedal was depressed, and released. I worked out the sustain circuit—a charged capacitor which kept a transistor gated on for a while, unless you depressed another pedal and discharged it abruptly.

And the queer bias? I realised that the pedal circuit was being fed with square waves from the generators in the main body of the instrument. The pedal circuitry simply had to pass a square wave of the required frequency, to be filtered or "voiced" later. The transistors therefore didn't need to operate as linear amplifiers. If they were overdriven and tended to square the already square wave input, what did it matter?

In fact, this realisation exonerated most of the circuitry from possible blame in regard to the changing signal level. The pedals were certainly selecting the right note and, in due course, it passed through a series of flip-flop frequency dividers to produce the necessary 4', 8' and 16' tones.

And, flip-flops being what they are, the output would be unlikely to vary unless with a variation in the supply voltage—and this could readily be checked.

But wait: Following the signals through, I realised that they did pass through one final stage which was subject to the keying or gating bias.

And here I struck oil. As I looked at the circuit, I realised that the gated transistor was virtually the bottom half of a signal voltage divider. When the transistor was turned on, and bottomed, virtually no signal would get through. When the bias was removed, and the transistor ceased to conduct, the divider would pass most of the signal to the amplifier.

What if that very obviously germanium transistor warmed up? Well, with zero bias, it would still conduct to some extent and attenuate the signal. And it could also have an effect on some of the time-constant skullduggery that was associated with it.

So, as the clock struck midnight, I reckoned I had found the culprit.

I was tempted to ring my friend there and then, as some kind of rough justice, but charity prevailed. Instead, I rang him next day and explained my theory, suggesting that he locate the particular circuit board and, if possible, the particular transistor. He could then put a weight on a bass note, wait till it faded down, and direct air from a fan on the board to see what happened.

In fact, I offered to lend him an output meter, if he called round, so that he wouldn't have to rely on his ears.

So it was, equipped with an output meter and a household fan, he duly attacked the job.

And with success!

He rang me later to say that, with the back off the organ and the fan playing on the board, the bass remained steady.

In fact, the circuitry was so sensitive that, even a finger resting on the metal can of the particular transistor would keep it cool enough to maintain the bass level. Yes even a warm finger!

The blade of a screwdriver had the same effect. What could he do to avoid the necessity for using a fan, or a finger or a screwdriver?

So, over the phone, I told him how to fashion a springy heat sink which he could clip on to the offending transistor, taking care that it did not contact any other part of the circuit. This he did—and played happily on the organ through the rest of the summer.

In fact, I gather that the word has since got around to owners of similar organs. It must have been a quite marginal effect, because some of them suffered with it to some extent, others not at all. It was all a matter of residual leakage of typical germanium transistors in the Australian summer.

But, apparently, the little heat sink did the trick in all cases.

So there you are: a "remote" service job that took a couple of years to complete and made happy the owners of at least three electronic organs.

And my reward? A grateful friend and no "bread"!

A full ASCII-type input keyboard for EDUC-8

Continuing the description of suitable peripheral devices to interface with his EDUC-8 microcomputer project, the author here gives details of a full alphanumeric input keyboard unit. The logic is capable of fully encoding all 128 characters of the standard 7-bit ASCII code.

by JAMIESON ROWE

Although the simple 16-key input keyboard unit described earlier is likely to be adequate for many purposes, there will no doubt be some constructors who will want to provide their EDUC-8 microcomputer with a full typewriter-style keyboard unit. Apart from offering increased communication flexibility and convenience, a full keyboard also allows you to work with programs requiring full alphanumeric input, such as symbolic editors, assemblers and compilers.

With this in mind I have developed a design for a full ASCII-type input keyboard, which will be described here.

The logic circuit has been designed to work with any keyboard assembly having the required number of switches, providing these can be used as SPST or "form A" switches (normally open, but closed when the key is pressed). The switches need not be bounceless, as the logic will cope with any normal amount of contact bounce.

I have built up the design and checked it out with a surplus keyboard switch assembly, typical of the type available in obsolete keypunch equipment. This type of keyboard is likely to be that most accessible to you, at reasonable cost. Providing the switch contacts are in reasonable condition, such a keyboard should be quite suitable, although most will need a thorough dusting, lubrication and treatment with contact cleaning fluid before use.

You can, of course, elect to wire up the keyboard using a new keyswitch assembly, of which a number are available—at an appropriate price. For example General Electronic Services (99 Alexander St, Crows Nest, NSW 2065) can supply a 56-key keyboard assembly made by Mechanical Enterprises, Inc., of Virginia. Designated type AA-L2-R2, it has gold contacts, an 8-keylength space bar, and two 1½-keylength shift keys. The price is approximately $130.

A new keyswitch assembly will undoubtedly give you a better looking keyboard, and ultimately greater reliability. However, as the cost of a surplus keyboard is unlikely to cost you more than about $10-20, there is a considerable cost incentive in "making do" with one of these.

The keyboard unit shown in the pictures is from the same surplus keypunch station which provided the Welmec reader and punch units previously described. It is fairly typical of the sort of keyboard switch assembly you are likely to obtain from such sources, solid in construction and still quite serviceable despite many years of work.

The keyboard logic presented here is capable of encoding all 128 characters of the standard 7-bit ASCII code, in contrast with some of the alphanumeric keyboard designs published elsewhere. In addition, the logic incorporates reverse shift mode encoding, for those keys where this is normally used.

Incidentally, if you've forgotten what the acronym "ASCII" stands for, it is the American Standard Code for Information Interchange.

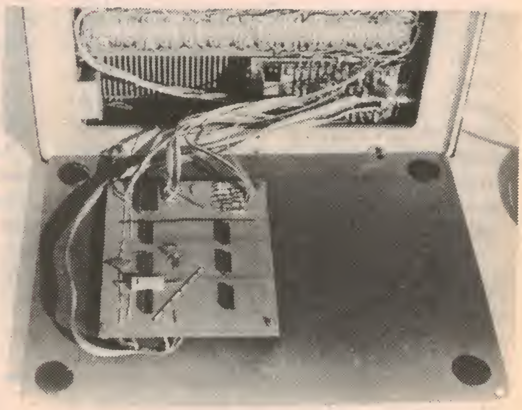
For the benefit of those not too familiar with the ASCII code, it is shown in Table 1. As you can see, the 128 characters are arranged in eight columns, each column having 16 rows. The 16 row positions are defined by the four least significant bits of the code, bits 0-3, while the three remaining bits are used to define the columns. Each one of the 128 character cells in the array is therefore defined by a unique combination of the 7 encoding bits.

Columns 2, 3, 4 and 5 comprise the printing characters normally used on teletypewriters and printers (such as the Philips 60SR printer, for example). These columns include all of the upper-case alphabetic symbols, the decimal numerals, and all of the commonly used punctuation marks. The 64 characters concerned are often considered as a distinct sub-set of the full 128-character code, known as "6-bit ASCII".

As far as keyboards are concerned, the characters in columns 4 and 5 are normally provided with keys of their own, while those of columns 2 and 3 are usually arranged to share common keys, with a "shift" key used to change the encoding and distinguish between one column and the other. Usually the characters in column 3 are the "normal" characters for these keys, and those in column 2 the "shift" characters—except for the character pairs in rows 12, 13, 14 and 15. These usually follow the reverse convention, with comma, minus, fullstop and oblique the "normal" characters and their corresponding characters the "shift" equivalents.

This special treatment of the four keys concerned tends to complicate the logic, as we will see shortly. However it has apparently become standard because of the greater use normally given to the four characters in column 2, compared with those in column 3. It would be a nuisance having to press the shift key every time one wanted a comma or fullstop, for example.

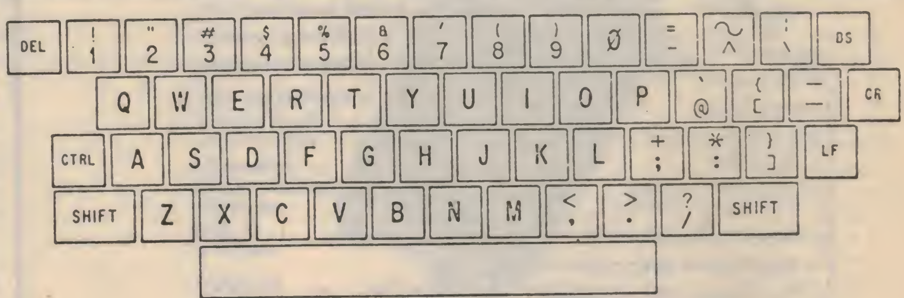
Columns 6 and 7 of the table comprise the lower case alphabet and some infrequently used symbols and control codes. Many keyboards do not provide for these codes to be generated, apart from "del" (delete or rubout) and perhaps "alt mode". This is because lower case characters are not necessary in most communication, and are not even available on many printers. For



At left is the prototype keyboard unit, which is built inside the case of a surplus keypunch keyboard. The view above shows the logic board, mounted on the bottom plate of the case.

TABLE 1 : ASCII CHARACTER CODE															
							b_6 →	0	0	0	0	1	1	1	1
							b_5 →	0	0	1	1	0	0	1	1
							b_4 →	0	1	0	1	0	1	0	1
B6	B5	B4	B3	B2	B1	B0	COLUMN → / ROW ↓	0	1	2	3	4	5	6	7
			0	0	0	0	0	NUL	DLE	SPACE	0	@	P	\	p
			0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
			0	0	1	0	2	STX	DC2	”	2	B	R	b	r
			0	0	1	1	3	ETX	DC3	# (£)	3	C	S	c	s
			0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
			0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
			0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
			0	1	1	1	7	BELL	ETB	’	7	G	W	g	w
			1	0	0	0	8	BACK SPACE	CAN	(	8	H	X	h	x
			1	0	0	1	9	HOR. TAB	EM	)	9	I	Y	i	y
			1	0	1	0	10	LINE FEED	SUB	*	:	J	Z	j	z
			1	0	1	1	11	VERT. TAB	ESCAPE	+	;	K	[	k	{
			1	1	0	0	12	FORM FEED	FS	,	<	L	\	l	ʃ
			1	1	0	1	13	CARRIAGE RETURN	GS	—	=	M	]	m	} (ALT MODE)
			1	1	1	0	14	SHIFT OUT	RS	.	>	N	∧ (↑)	n	~
			1	1	1	1	15	SHIFT IN	US	/	?	O	_	o	DEL (RUB OUT)

Above is a table showing the 128 characters of the 7-bit ASCII code, with their coding. At right is the standard keyboard format used for this code.



the same reason it is usual for the upper case characters to be the "normal" characters, with the lower case characters in columns 6 and 7 encoded by using the shift key—just the opposite of the convention used with typewriters.

The characters in the remaining two columns, columns 0 and 1, are known as the non-printing or "control" characters. These are used to indicate changes in encoding mode, to control printer formatting, and for other facilities which may need to be controlled by "transparent" character codes—distinguishable from printing characters.

Generally most of the codes in columns 0 and 1 are generated using a "control" key, which acts rather like a second shift key. Any desired code in column 0 is generated by pressing the control key in conjunction with the key in column 4 corresponding to the desired row code. Thus "form feed" may be generated by pressing "control" and "L", while "horizontal tab" is equivalent to control-I.

In some cases special keys are provided for column 0 character codes, because they are used fairly frequently. This is generally done for "carriage return", "line feed", "back space" and "bell"—the last of these being used to activate the signalling bell of a teletypewriter.

The codes in column 1 are normally generated by using the control key in conjunction with the keys for columns 3/2, although some teletypewriters provide a special key for "escape".

Note that the characters in the ASCII code are not completely rigid, with certain codes being used to represent two different characters on occasion. Thus the character in row 3 of column 2 is generally the "number" sign on American equipment, but the "pound" sign on machines of UK origin. Similarly the code in row 13 of column 7 is sometimes used to represent "wiggly closing bracket", and sometimes the non-printing control key "alt mode".

All of the character codes shown in the table may be generated using the logic circuit which will now be described. As many special keys as desired may be used to generate column 0 and 1 codes, depending upon the number of keys available on the keyboard you use. The remaining codes may be generated using the control key. Similarly the shift key may be used to generate the characters in columns 6 and 7, although "del" may be provided with a special key if you so desire.

As you can see from the circuit diagram, the main alphanumeric keyswitches are wired in an array, whose rows and columns correspond to those of columns 2, 3, 4 and 5 of Table 1. There are 16 "row" keylines, and three "column" keylines—two of which correspond directly to columns 4 and 5 of the table, while the last corresponds to both columns 2 and 3 (which use common keys).

At the heart of the encoding logic is an IC specially designed to perform keyboard encoding. This is the HD-0165, made by Harris Semiconductor in the USA. It is available on order through your usual parts supplier, from the local agents for Harris, Cema Distributors Pty Ltd of 21 Chandos Street, Crows Nest, NSW 2065. At the time of writing it costs about $9, but performs a job which would otherwise involve many diodes, transistors and ICs.

The HD-0165 is a 16-line to 4-line binary encoder, which also generates both a "strobe" or "key pressed" signal and a "rollover" or "more than one key pressed" signal.

As you can see from the circuit, the HD-0165 is used to perform the basic encoding of the four least significant bits. As this corresponds to the row encoding for Table 1, its 16 inputs accordingly connect to the 16 "row" keylines of the keyswitch array.

Encoding of the remaining three bits of the ASCII code is performed by the logic circuitry involving gates G6, G7, G10-12, and inverters I1-6, using signals derived from the "column" keylines. The actual column keyline signals are generated by PNP transistors T1, T2 and T3.

These are wired so that when any of the keys in the associated keyline is pressed, the resulting input current drawn by the HD-0165 passes through the base-emitter junction, turning the transistor on.

Further logic signals are generated by the "shift" keyswitch, and the "control" keyswitch. Special keys such as "carriage return", "line feed" (LF), "back space" and "bell" are arranged to have the same effect as if the control key were pressed along with the corresponding column 4 alphabetic key, by means of diodes D3-D10. Thus D3 and D4 ensure that the carriage return key generates the "control" and "M" signals, as well as causing T3 to conduct.

As the "space bar" key is equivalent to "shift-0", diodes D1 and D2 are used to achieve a similar result when this key is pressed. Here the key causes activation of the "0" input of the HD-0165, generation of the "shift" signal, and conduction of T1—all three of which are needed to achieve the same result as shifted zero.

The actual encoding for bit 4 is generated at the commoned outputs of gate G6 and inverter I3. These are both open-collector elements, with their outputs tied together to achieve a wired-OR function. Similarly the bit 5 encoding is generated at the commoned outputs of G7-I4, and the bit 6 encoding at the commoned outputs of I5-I6.

The inputs of these elements are fed with the column keyline logic signals from T1, T2 and T3 together with the control and shift keyline signals, to achieve the correct encoding. For example I4 is fed with the control keyline signal, to ensure that bit 5 is false (0) whenever the control keyline is activated—corresponding to a column 0 or 1 character. Gate G7 is fed with the inverted shift keyline signal from I1, together with a wired-OR combination of the column 4 and 5 keyline signals from T3 and T2, so that bit 5 is again made false whenever a column 4 or 5 key is pressed without the shift key.

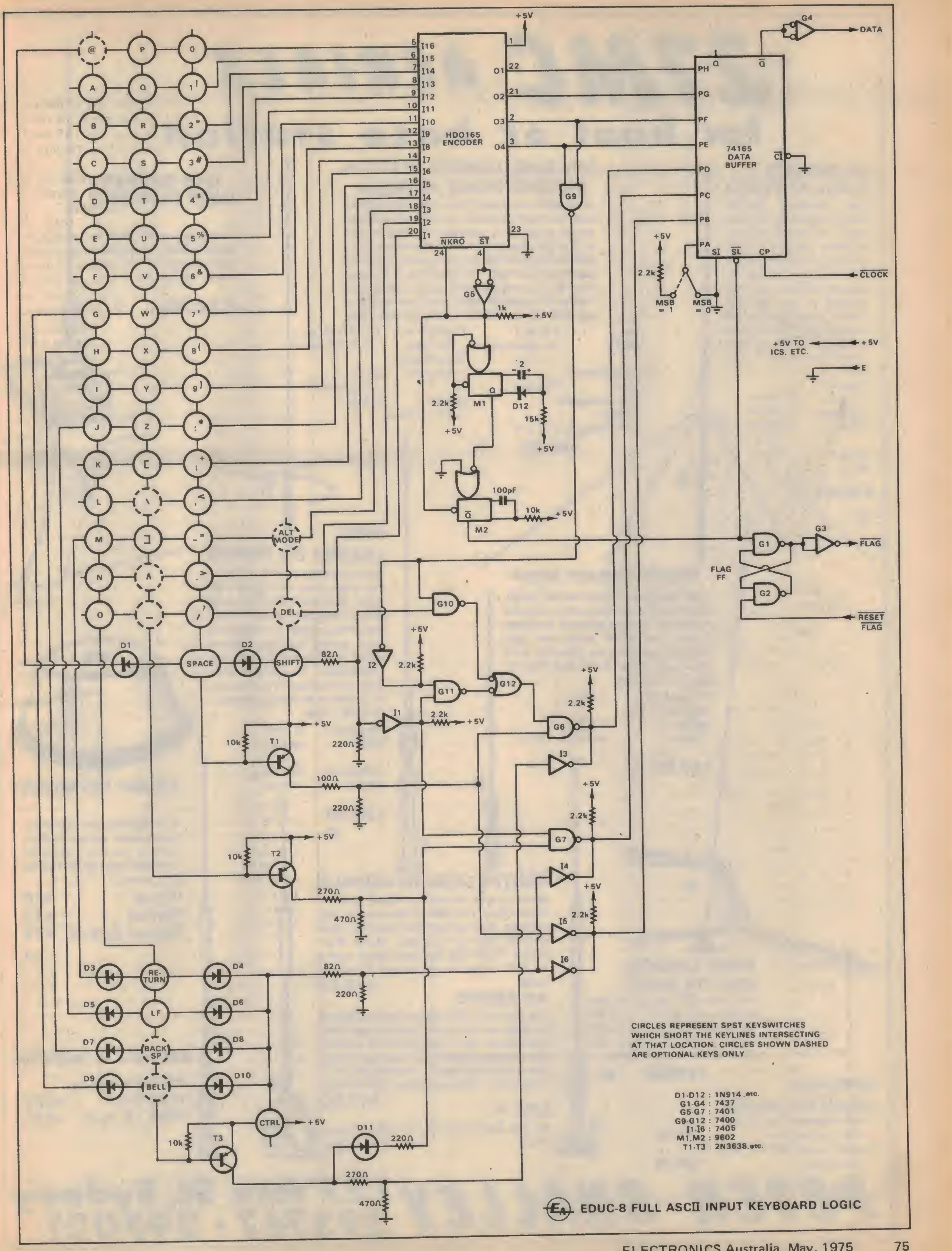
Similarly I5 and I6 are fed with the column 2/3 keyline signal from T1, and the control keyline signal, respectively, which ensures that bit 6 is false whenever a key or key combination corresponding to a character in columns 0, 1, 2 or 3.

Inverter I3 is fed with the column 4 keyline signal from transistor T3. As columns 0 and 7 are equivalent to column 4 characters combined with either the control or shift keys, this automatically ensures that bit 4 is always false for all column 0, 4 and 7 characters.

The signals fed to gate G6 are used to obtain the correct bit 4 encoding for columns 2 and 3. Because of the inverted shift mode operation of the row 12, 13, 14 and 15 keys, this is a little more complex than it might otherwise be. What must occur is that for the rows 0-11 keys, bit 4 must be false when the shift key is pressed, while for the rows 12-15 keys bit 4 must be false if the shift key is NOT pressed.

This is achieved by using gate G9 to monitor the bit 2 and bit 3 outputs from the HD-0165, so that its output is low whenever both these

Shown opposite is the complete circuit of the ASCII keyboard encoder. Encoding of the 4-bit row address portion of the code is performed by the Harris HD-0165 16-line to 4-bit encoder IC, at top centre.



CIRCLES REPRESENT SPST KEYSWITCHES WHICH SHORT THE KEYLINES INTERSECTING AT THAT LOCATION. CIRCLES SHOWN DASHED ARE OPTIONAL KEYS ONLY.

D1-D12 : 1N914 .etc.
G1-G4 : 7437
G5-G7 : 7401
G9-G12 : 7400
I1-I6 : 7405
M1,M2 : 9602
T1-T3 : 2N3638.etc.

EDUC-8 FULL ASCII INPUT KEYBOARD LOGIC

27MC AERIALS

for boat or base station

36 GROUND PLANE ANTENNA

High efficiency Ground Plane Antenna for CB base station. All aluminium construction. Accepts PL-259 connector. Solid aluminium 108 inch heat-treated radials and radiator. Elements supplied in two 54 inch lengths joined by threaded coupling nuts. Radial droop for 50 ohm match. Accepts 1-¼ inch tubing and PL-259 connector.

Frequency range:	27 MHz
Impedance:	50 ohms
VSWR:	less than 1.5:1
Weight:	4.5 lbs
Wave	¼

$35.00

G

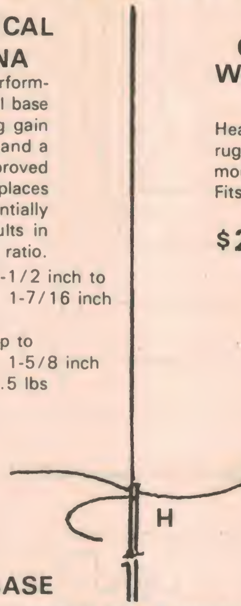
G

GPV BASE LOADED VERTICAL GROUND PLANE ANTENNA

A ruggedly constructed low-cost high performance vertically polarized, omni-directional base station antenna. It develops transmitting gain of 3.8 dB through pattern compression and a lowered angle of radiation along with improved signal-to-noise ratio. The matching stub places it at DC ground potential which substantially lowers the residual noise level and results in gains as high as 19 dB in signal-to-noise ratio.

Gain:	3.8 dB	Diameter of Radiator:	1-1/2 inch to 1-7/16 inch
VSWR:	(at resonance) 1.25:1	Mast Bracket Accepts:	up to 1-5/8 inch
Coaxial Feed-line:	52 ohms	Weight:	5.5 lbs
Omni-directional Pattern		Full 1/2 Wave	
Overall Height: 212 inch			

$49.50 H

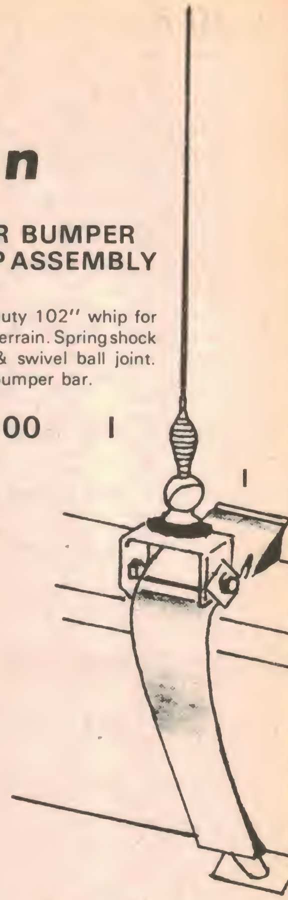


H

CAR BUMPER WHIP ASSEMBLY

Heavy duty 102" whip for rugged terrain. Spring shock mount & swivel ball joint. Fits to bumper bar.

$28.00 I



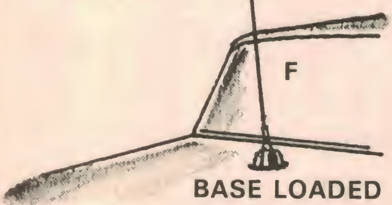
I

TRUNK MOUNT WHIP

Solid fiberglass whip extremely tough. Centre loading wound on whip—covered with black abrasion-resistant Thermofit tubing. Flat VSWR across the band excellent performance. Includes trunk lid mount. Cable & PL 259 plug removed in seconds.

Frequency:	27 MHz
Only 48.5" high	
Weight:	1.0 lbs
VSWR:	less than 1.5:1

$27.50 F



F

D

E

BASE LOADED ON SPRING

Base loaded antenna with attractive grey jacket and chrome fittings. Stainless steel whip with adaptor that provides for 1-1/4" fine tuning adjustment. A stainless steel spring protects against shock. Antenna easily snaps into "Quick-Grip" mount. Solderless lead connection at antenna. PL-259 at set end of coaxial cable. Only 46" high.

Frequency:	27MHz
VSWR:	less than 1.5:1
Impedance:	50 ohms
Weight:	1.7 lbs

$29.50 E

J

TRUNK LID MOUNT

For mounting any of our mobile aerials without drilling holes in your car. Removed or fitted in seconds, also gutter grip version.

Trunk	$10
Gutter	$12
Gutter D/Lux	$16

J

BASE LOADED CLIP ON WHIP

This short 20" whip fits transceivers with 9/16" or 3/8" aerials. Simply slips over closed aerial stub-base loading coil gives excellent performance.

$12.00 D

CENTRE LOADED AERIALS

Short on size, but not on signal! Just 20 inches long. Includes centre loading coil, stainless steel spring and beautiful black phenolic base on the new "Quick Grip" mount. Solderless lead connection with a PL-259 connector at set end of coaxial cable. **$19.50**

AS ABOVE

The gutter clip CB mobile antenna designed to mount on rain gutter of any automobile. Features no hole installation. All antenna parts chrome plated brass or stainless steel. Gutter clamp zinc plated. Includes RG 58/U cable and PL-259 connector. (No Spring). **$17.50**

LIKE A

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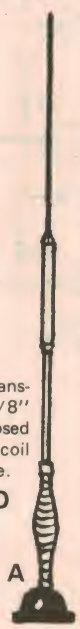
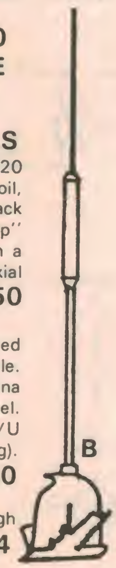


A



B

C

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EDUC-8 computer

bits are high — signifying a row 12, 13, 14 or 15 character. This signal and its complement are then gated with the shift signal and its complement, by gates G10 and G11. The outputs of these gates are then combined by G12, performing an OR function. Finally G5 gates the resulting logic signal with the column 2/3 keyline signal from T1. If you trace all this through, you'll find that it does the required job. Monostable elements M1 and M2 are used to generate a clean "key pressed" signal from the strobe (L) and N-key-rollover (L) outputs of the HD-0165. In the configuration shown, they both suppress key contact bounce, and also prevent encoding errors due to accidental pressing of more than one key.

Gate G5 is an open-collector element, used as an inverter for the HD-0165's strobe (L) signal. When a single key is pressed, the output of G5 thus goes high, and carries with it the trigger input of monostable M1. M1 thus triggers, and its ouput goes high for a period of approximately 20ms. This interval is set by the 2uF capacitor and 15k resistor, with diode D12 used to compensate for possible capacitor leakage. The 20ms delay is to allow for keyswitch contact bounce to die away, before further events are initiated.

The Q output of M1 is connected to the complementary trigger input of monostable M2, so that when the output of M1 falls back to the low state at the end of the 20ms delay, M2 is normally triggered — producing a clean "key pressed" (L) signal at its Q-bar output. However because the reset input of M2 is connected to the output of G5, and both are tied to the "N-key-rollover" (L) output of the HD-0165, triggering of M2 can only take place if a single key remains pressed. If a second key has been pressed accidentally, the reset input of M2 will be held low, and it will be prevented from triggering.

If this occurs, correct triggering will take place when the second key is released, assuming that the intended key remains pressed.

The clean "key pressed" (L) signal produced at the Q-bar output of M2 is a pulse of approximately 500ns duration. The pulse is used to perform two functions, one being to enable the parallel-load input of the data buffer register — a 74165 device. This causes the encoded 7-bit ASCII character to be loaded into the buffer, ready for despatch to the computer.

The second function performed by the key pressed pulse is to set the flag FF, formed by cross-connected gates G1 and G2. Buffer gate G3 is thus able to take the flag line low, indicating to the computer that a character is available.

As with the other input peripherals described, the computer itself performs the actual data transfer, sending clock pulses to the data buffer register and accepting the data via the inverter/driver G4.

Note that as the EDUC-8 input/output circuitry is designed to handle 8-bit numbers, the keyboard data buffer is an 8-bit register. This means that there is a spare bit, as only seven are used for the ASCII encoded characters. The eighth bit may be set permanently to either a high (H) or low (L), as desired, by tying the PA input of the 74165 either to +5V (via a protective resistor) or to ground, as desired.

In many minicomputer systems the eighth bit produced by an alphanumeric input keyboard unit is permanently set to high (1), as this allows ready identification of alphanumeric or "symbolic" character strings. I have used the same convention, and I suggest you do too.

In the prototype keyboard unit shown in the photographs, most of the logic was wired up on one of our multi-DIP utility PC boards. This was then mounted on the bottom plate of the keyboard case, using suitable spacers. Pieces of flat multi-coloured cable were used to connect the board to the keyswitches, and to transistors T1, T2 and T3. These were mounted for convenience on some existing tagstrips inside the main keyswitch frame.

Before using the keyboard assembly, it was necessary to remove all of the existing switch wiring as this was arranged in a connection array quite different from the one required. Before wiring the switches according to the new array, the complete assembly was cleaned thoroughly and the key contacts sprayed with one of the aerosol contact cleaning fluids.

At the same time, the opportunity was taken to re-arrange some of the keytops, so that the keyboard became closer to that used in a typewriter or teleprinter. You may care to do this also, as the keys on many keypunch keyboards have the keys in rather different positions. The keys and positions of a normal ASCII keyboard are shown in the diagram, to help you if you want to aim for an arrangement as close to this as possible. I recommend that you do this unless you have a good reason to do otherwise.

As before, the keyboard unit connects to the computer via a length of multi-way cable, and a 6-pin DIN plug. As well as performing the logic signal connections, the cable also supplies the keyboard logic with its 5V DC power.

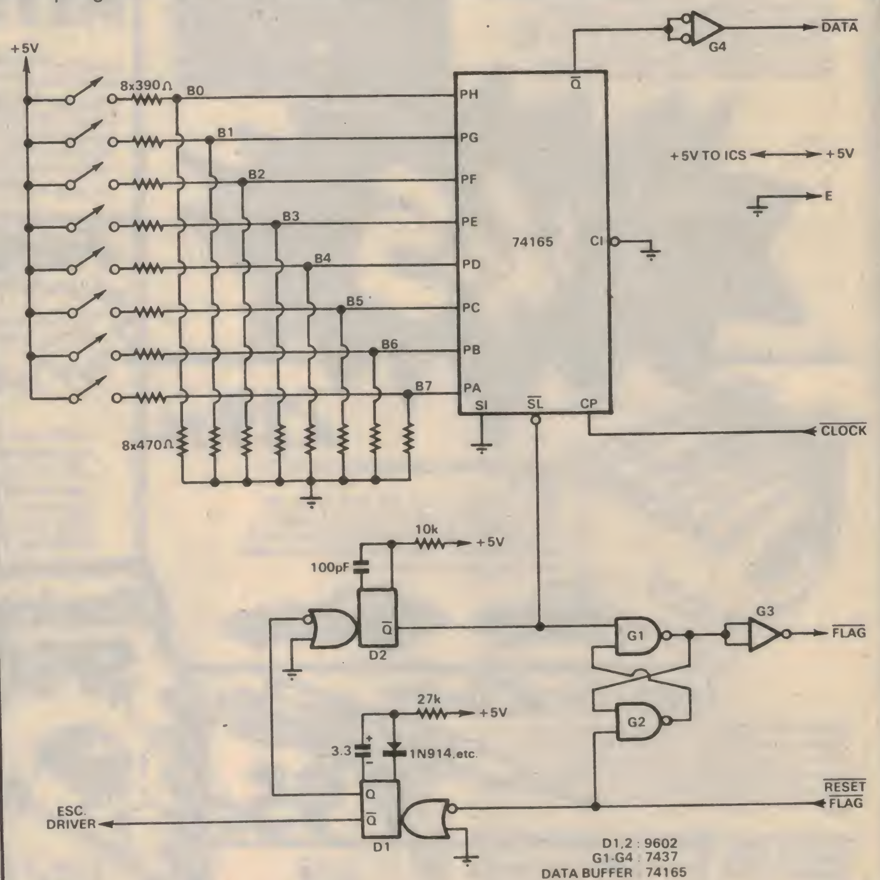
MODIFIED TAPE READER LOGIC—CORRECTION

There is an old rule in electronics publishing, that it is very unwise to publish a circuit you haven't actually tried. It is almost inevitable that if you do so, the circuit won't work! I have proved the rule still applies, much to my embarrassment. In the description of punched paper tape peripherals, the circuit I gave in Fig. 6 showing how to modify the program-controlled reader logic for use with a motor-clutch type reader mechanism had not actually been tried. Due to lack of time, I had deduced it by analogy from Fig. 4.

Needless to say, it won't work properly. The main problem is that there is no way for the computer to know when the clutch mechanism has incremented the tape.

Rather than attempt to patch up this circuit, I have started again from scratch. And the effort was worthwhile, because it turns out that the job can be done much more simply, using only three ICs—a 74165 as the data buffer, a 9602 dual monostable for timing, and a 7437 for the flag FF and line drivers. The circuit is shown below, and it should be fairly self-explanatory. It should be taken to replace the original Fig. 6.

PLEASE NOTE ALSO that the parts list given for the program counter and adder board (main computer parts list 3) is in error. It should list only 4 x 7400 or 9002 quad 2-input gates, not 5, and it should list 1 x 7420 dual 4-input gate.



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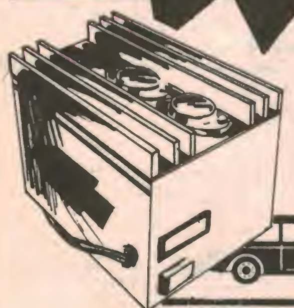

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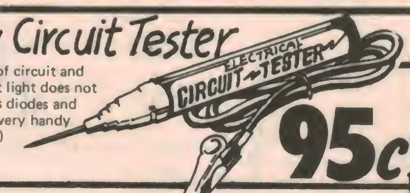

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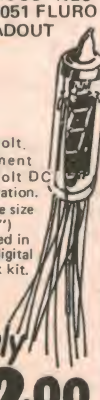

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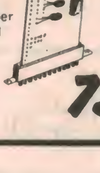

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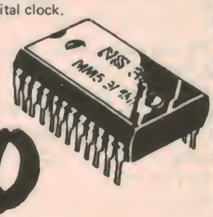

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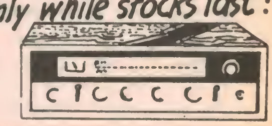

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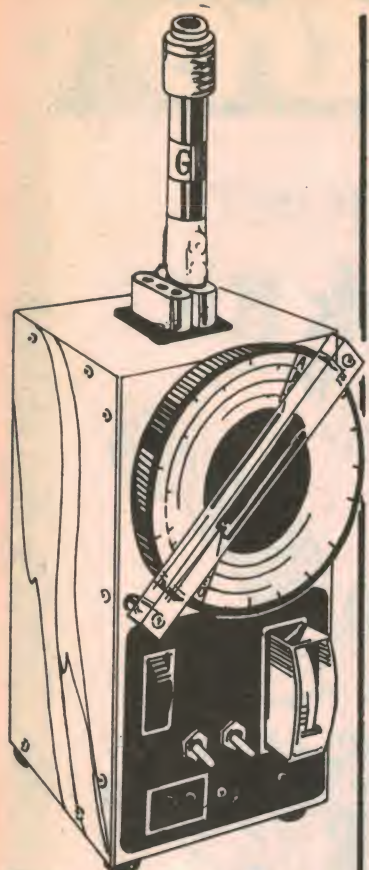

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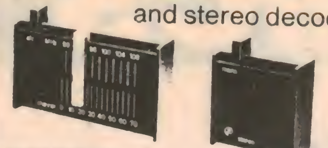

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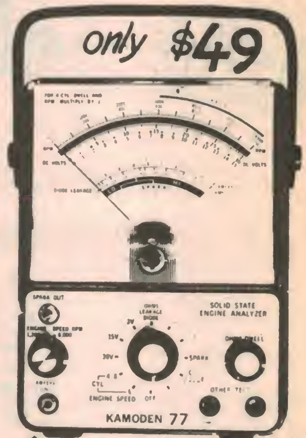

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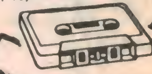

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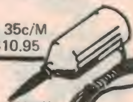

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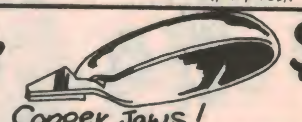

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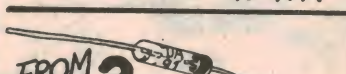

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Circuit & Design Ideas

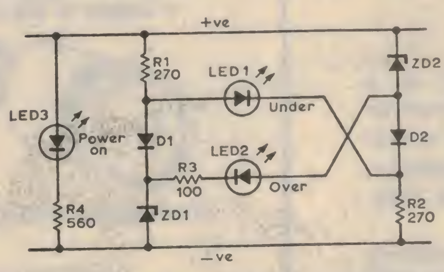
Conducted by Ian Pogson

Interesting circuit ideas and design notes selected from technical literature, reader contributions and staff jottings. As they have not necessarily been tested in our laboratory, responsibility cannot be accepted. Your contributions are welcome, and will be paid for if used.

LEDs monitor supply voltage

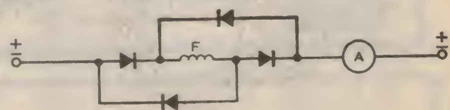
Yet another use of LEDs turns up in an item by Marvin J. Moss in "Electronic Design". This is in the form of a voltage monitor for 12V supplies, indicating both over or under tolerance voltages. Using three LEDs the user can see at a glance whether power is on, over-voltage or under-voltage. This is achieved by means of a balanced bridge that uses zener diodes ZD1 and ZD2 in the bridge's opposite arms and back-to-back LEDs between the mid-points of the bridge arms.

If the input voltage does not exceed the two zener breakdown voltages (2 x 6.8V = 13.6V), LED1 lights. But above 13.6V LED1 becomes reverse biased and remains off. When the input voltage increases to the extent that at the junction of ZD2 and D2, it exceeds the zener voltage of ZD1, plus the LED voltage of 1.6V, then LED2 is turned on, with R3 limiting the current through the LED. By mixing of silicon and germanium diodes, etc, it might well be possible to decrease the voltage tolerance. The total drain of the circuit as shown is of the order of 50mA, which is not excessive for car batteries or mains units although would have to be considered for dry battery operation.



Motor reversing using silicon diodes

C. Draper, G3TSK, two years ago built an aerial rotator using a 24V Meccano motor and some gears—and devised an interesting means of reversing the direction of the motor. Rather than put a relay in the motor box where it would be subject to inclement weather conditions, he used the system shown in the diagram, based on diodes. These are arranged so that they effectively change over the armature winding depending on the polarity of the supply.



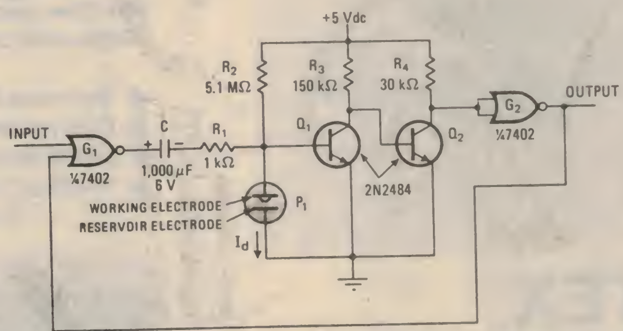
(From "Radio Communication".)

100-hour timer uses plating cell

A timer with output durations ranging from a few seconds to more than 100 hours can be built around a plating cell, thus avoiding the special low-leakage components or high resistances that such timers often require.

When the current direction in a plating cell is from reservoir electrode to working electrode, silver is plated onto the working electrode in an amount proportional to the charge passed through the cell. Conversely, when the current direction is from working electrode to reservoir electrode, silver is removed from the working electrode. As long as the electrode is plated, the impedance of the cell is only a few kilohms; but after all the plating is removed from the anode, the impedance across the cell increases to several megohms. When this happens, transistor Q1 is turned on; otherwise, when the cell is plated, Q1 is cut off.

The plating charge is the charge on capacitor C. When the input and output have both been low for a long time, C has charged fully to about 3.6V, and at 1000uF as shown, it holds 3.6×10^{-3} coulomb. Then, when the external input to gate G1 goes high, its output drops to ground and C discharges through the plating cell. The current Id, with the reference shown, is negative, causing the cell to be plated. The magnitude of the current is limited by resistor R1; the time constant for the values shown is about 1 second. Plating the cell drops the voltage at the base of Q1 below its threshold, thus turning Q1 off and Q2 on. The collector of Q2 drops almost to ground; this level is inverted by gate G2 and the output goes high. This output feeds back to gate G1 to make the circuit operation independent of the input line once the timing cycle has begun.



Choice of RC time constant gives times from seconds to more than 100 hours. P1 is a Plessey E-Cell, type 560-0002.

The deplating current flows continuously through R2; it is 1uA for the value of R2 shown. When deplating is nearly completed, the impedance of the cell begins to increase gradually, Q1 turns back on, the timer output goes low, and if the timer input is low, capacitor C charges again.

The charge transferred during either plating or deplating is represented by

$$Q = CV = IdT$$

From this relationship, the time to transfer this charge is

$$T = CV/Id$$

For a 1000uF capacitor, the time to deplate the cell is 3600 seconds, one hour. Other times can be obtained by using different values for the capacitor C or the resistor R2.

(By Ken Erickson, in "Electronics".)

Classical Recordings

Reviewed by Julian Russell

A new batch of Dolby cassettes

All the cassettes reviewed in this column are Dolbyised—or wouldn't "Dolbyed" perhaps be a better word? When I reviewed my first batch of Dolbyed cassettes on Dolbyed equipment in last January's issue of "Electronics Australia", I wrote that, good as they were, they just failed to be as good as the very best disc recordings. I have since had occasion to change my mind. The recording of cassettes varies just as does the recording of discs; i.e., some are better than others. But the best of the cassettes I am reviewing this time are as good as any discs I have ever heard. I do not know if one would get an equally good result from a very weighty choral and orchestral work because I have so far heard none on this medium.

But I must reiterate another advantage of the cassette set-up. The user is freed from the nuisance of an inferior pressing from which no amount of cleaning will make the pops and crackles disappear. Dolbyed cassettes to which I have listened often have more stable stereo separation than some by no means unimportant discs. Having set your balance there is seldom any need to readjust it, which is more than can be said about even the best recorded discs. I am reluctant to prophecy that cassettes will supplant discs completely in the near future. I myself own too many discs to which I am attached and which have long since been deleted from circulation to wish this to happen. But I consider I am perfectly safe in predicting a fast widening market for the Dolbyed cassette.

By the way I must apologise to any of my readers who found some of the cassettes I reviewed in the January issue unobtainable in Australia. Phonogram Ltd., the distributors allowed me to pick those I wanted from a large collection and unfortunately I chose some that were samples, not yet issued in Australia, although they are already on the market overseas. However I now learn that, by the time this review appears, all those I mentioned in January should be obtainable here.

MOZART—Symphonies Nos. 25 in G Minor (K. 183), 26 in E Flat (K. 184) and 27 in G Major (K. 199). Berlin Philharmonic Orchestra conducted by Karl Bohm. DGG stereo cassette No. 3300 337.

No one could wish for better sound than they will hear in these three early Mozart symphonies. It is beautifully transparent, not a note of detail is missing and the tonal quality of the Berlin Philharmonic superb. There is, too, the unrivalled Mozart conducting of Karl Bohm. These symphonies were composed after Mozart's third and last visit to Italy. Despite the Kochel numbering, No. 184 was written before No. 183 and shows a stronger Italian influence, so much so that it may be described as in the Italian Overture style. In keeping with this style you will find little formal development in the first and third movements, although Mozart provided a deeply felt contrast in the Andante, putting it in a minor key and introducing many novelties—of genius even at that early age—in his use of dialogues between different instruments.

Although only 17 years old, he already showed extraordinary precociousness in his firm grasp of the orchestral medium. The combination of Bohm's superb conducting and the peerless playing of the Berlin Philharmonic makes it a memorable performance. To some, Bohm's tempos might seem a little on the slow side at times but this is well within the central European tradition. And there is ample compensation even to those who prefer slightly faster tempos in the compelling drive behind everything Bohm plays.

The K. 183 in G Minor will promote inevitable comparisons with the later "big" G Minor, one of the last three symphonies Mozart composed before his early unhappy and completely wasteful death. In this it is the slow movement that is in a major key and provides comforting balm after the grief-laden G Minor first movement.

It is a movement of quite seraphic serenity. You will find lighter relief still in the menuetto and Bohm takes the Finale with its wonderfully lucent part writing very seriously; some might think a trifle too seriously. But although I can appreciate their point of view, I find Bohm's reading absolutely right.

K. 199, is a still earlier work although even here you might marvel at the originality of the instrumental dialogues over a pizzicato bass in the slow movement. The fast Finale has a most delicious lilt. I can think of nothing but the highest praise for the whole production.

★ ★ ★

MOZART—Concerto for Two Pianos (K. 365) Emil and Elena Gilels (pianos) with the Vienna Philharmonic Orchestra conducted by Karl Bohm. Concerto for Piano and Orchestra (K. 595). Emil Gilels and the VPO conducted by Karl Bohm. DGG Stereo Cassette No. 3300 406.

Although Gilels is one of the finest pianists playing today, this is the first time I have ever heard him in Mozart. From his very first bars there is never a doubt that he is as great a performer of the music of this composer as he is of so many others. In the Double Concerto Gilels is joined by his gifted daughter Elena. The rapport between the two is complete, both players showing the same engaging fluency and nuancing. Their tempos always sound just right and the tricky job of balancing the two pianos against the orchestra is always completely successful. The concerto is a happy, some times even joyous work, the creation of a young genius who had risen above the bitterness and humiliations suffered during his Paris visit. Soon to be followed by pain at the loss of his mother. The contribution of Bohm and the VPO adds to the triumph of the soloists.

In the K. 595—Mozart's last piano concerto—the light-heartedness of the earlier work has gone but it is again an example of other disappointments conquered by an indomitable spirit. This concerto—one of the greatest—is renowned for its almost entire lack of emphasis and point making. Here is true serenity untroubled except on rare occasions by a slightly raised voice. Yet as played by Gilels, and Bohm, there is no sense of monotony of emotion or greyness of texture. Only considerations of space prevent me from continuing my unqualified praise of the work and its performance. So I confine my remarks to the advice—don't miss it.

★ ★ ★

BRAHMS—Piano Concerto No. 1 in D Minor. Alfred Brendel (piano) and the Concertgebouw Orchestra of Amsterdam conducted by Hans Schmidt-Isserstedt. Philips Stereo Cassette No. 7300 281.

I must confess to considerable disappointment in this cassette, although this is limited to the manner of performance and not its engineering. For instance, the usually potent Schmidt-Isserstedt begins the first movement introduction with, here and there, a surprising lack of vitality. It sounds in fact very, very ordinary. When the piano enters its tone is at first

a little dry and percussive though this is corrected further on the tape. Brendel's reading is characteristically studious but there is an unsmiling atmosphere about his playing, even in the feminine second subject, that I found less than attractive. To me he comes perilously close to sounding irritatingly metronomic—I nearly wrote wooden. There are, of course, some very beautifully played passages, pianissimo figurations of delicious delicacy and fluidity. But elsewhere in this movement I had to concentrate hard to prevent my attention from wandering. Correct it undoubtedly is, but oh so starchy. And this might explain Schmidt-Isserstedt's reflection of Brendel's unexciting playing by accommodating these moods in the orchestral part.

In the slow movement the conductor starts warmly although his tempo is nearer to largo than adagio, which latter is the way Brahms marked his score. But, judging by the way Brendel continues the movement, this is the way he wanted it. On the other hand, one important point in Brendel's favour throughout the concerto is the exhibition of unforced power he has at his command. And in the Finale all lethargy vanishes. It is played right up to tempo and produces a very spirited performance from both soloist and orchestra with moments of enchanting delicacy by way of contrasts. There is, too, an admirably sustained balance between pianist and orchestra, no matter how soft or loud the sound issuing from the speakers.

★ ★ ★

SIBELIUS—Symphony No. 1 in E Minor. Symphonic Poem. The Bard. Radio Symphony Orchestra of Helsinki conducted by Okko Kamu. DGG Stereo cassette No. 3300 401.

I enjoyed both the playing and recording of this cassette immensely. The opening lonely clarinet solo establishes the right atmosphere instantly. Then the rest of the fine Finnish orchestra enters with alluring warmth of tone in the strings and a fine cutting edge on the brass. The conductor's reading of this turbulent score is unabashedly romantic. It differs slightly in detail from that of his great Finnish predecessor, Kajanus, who recorded the symphony on 78s back in the 1930s, especially in his treatment of the almost whispered pianissimos. But otherwise I found Kamu's interpretation of the stormy first movement just as exciting. The sound is outstandingly impressive with its very wide range of dyhamics and frequencies. Kamu uses the many climaxes to fine effect without obscurring any of the finer details of the score.

He starts the first subject of the slow movement with quite ravishing tenderness sustained throughout and the end fades firmly but exquisitely into silence. Kajanus perhaps got a little more devil into the scherzo—so, too, did that other fine Sibelius conductor, Collins—but Kamu's reading will still do very well. There is not an untidy bar anywhere. True this Helsinki orchestra must know the piece so well that they could probably make a good job of it in complete darkness. But this is not meant to detract from Kamu's performance in any way. He makes the Finale as majestic a conclusion as that of any romantic symphony, taking it all with impressive breadth.

No information about the second item on the cassette, The Bard, also by Sibelius, is included in the cassette notes though the fact that the music is so self-explanatory makes their omission unimportant even to those who are hearing the piece for the first time. The Bardic atmosphere is created by a series of harp passages in the accompaniment to its solemn but haunting melody. But even without this association, the music in itself is no less than superb and Kamu does it full justice observing every shade of expression. Sibelius wrote many symphonic poems but none—even Tapiola—better that The Bard. I can only describe it as supremely eloquent in its sad, narrative beauty. Very strongly recommended to those with a romantic bent who are meeting Sibelius for the first time.

★ ★ ★

TCHAIKOVSKY—Symphony No. 6 in B Minor (Pathetique). Vienna Philharmonic Orchestra conducted by Claudio Abbado. DGG Stereo Cassette No. 3300 405.

Here is another romantic symphony that I can recommend in every way to those who have enough sense not to affect scorn of the composer. For there exist, or did until recently, people—even critics—who profess contempt for one of the world's greatest writers of melodies, whatever formal deliquencies are to be found in his symphonies. But not everyone looks for the closely dovetailed workmanship of Beethoven in symphonic literature, nor the long, rambling, often mystical and still more frequently banal neurotic compositions of the composer of the minute, Gustave Mahler. Tchaikovsky has often been accused of writing clumsy fast passages for strings. Perhaps he did. My instrument was the piano so I cannot confirm or deny this. But one thing I know for sure, and that is that Tchaikovsky's string passages, fast and slow, sound glorious as played by the Vienna Philharmonic under Abbado on this cassette. For this is still another that has my unqualified recommendation. Abbado offers an excellently proportioned first movement, the intro one of solitary sadness followed by an allegro non troppo at first restrained, almost dainty in its string phrasing. Even the famous second subject, popularised some years ago under the title of, I think, Starry Night (yuk) is slightly underplayed emotionally. It is not until you reach the hoarse-voiced brass in the great climax that you realise just how carefully and effectively Abbado has laid out the music. It is an agonised yet never undignified statement in which self-pity is kept to a minimum.

The movement closes in a mood of exhausted despair with the melody supported by giant pizzicato footsteps in the bass that somehow express—at any rate to me—the peace which comes with death.

Abbado uses the 5/4 time of the second movement to win a line of the most sensitive fluidity. Despite its time signature it never sounds the slightest bit lop-sided. And in the second subject he makes subtle uses of its repeats which are never taken as mirror copies of the original. The whole movement, despite its grace, has about it the languour of hopelessness.

The VPO strings start the scherzo with unmatched delicacy which would never prompt one to guess at the martial character of the music that follows later in the movement. If you play this movement as a sample, it will give you a good idea of the resources of modern cassette recording techniques. You will find it at the beginning of Side 2. And if this doesn't convince you of the superb standard of the playing and recording go on to the Finale with its great contrasts between the two moving subjects. Here is no Bernstein heart-on-sleeve showiness but deeply felt expression of the music without any hint of self-advertisement by the conductor. The grandeur of tone of the VPO has to be heard to be believed.

Variety Fare

Reviews of other recordings

Devotional Records

DINO PLAYS FOLK MUSICAL THEMES. With the Ralph Carmichael Orchestra and Chorus. Stereo, Light LS-5635-LP. Also on cassette. (From Sacred Productions Aust, 181 Clarence St, Sydney and other capitals.)

Identified only by his christian name, Dino is a young man with precisely what it takes to provide a very pleasant and entertaining sound on the piano. And Ralph Carmichael supports him with some fine arrangements and a generous orchestral backing.

The folk themes are taken from recent Christian musicals, from the pen of Ralph Carmichael, Kurt Kaiser, Jimmy Owens and others. Although the program is predominantly instrumental the words are given on the jacket, for those who may desire to follow them: My Little World – Jesus Never Forgets – He That Overcomes – Holy, Holy – Let It Ring/God Is Here Right Now – Joy Is The Centre of His Will – New Wine – Trusting Is Believing – Pass It On – My One Aspiration/Thank You Lord.

Whether or not the titles are familiar, I venture to suggest that you'll enjoy the big sound – melodic piano, full orchestra and touches of chorus. Those with a critical ear may detect a faint edge here and there on the strings and chorus but, all told, it's a highly successful album. (W.N.W.)

★ ★ ★

THAT THE WORLD MAY KNOW. Paul Johnson Singers. Stereo, Word WST-8623-LP. (From Sacred Productions Aust, 181 Clarence Street, Sydney and other capitals).

In some albums, hymns are presented more or less straight. In others they are so drastically rearranged that little of the original melody remains. The Paul Johnson singers and instrumentalists plot their course about midway between the two. The words and melodies remain substantially intact but the tempos and accompaniments are based on the current pop idiom: drums, bass, keyboards, percussion, guitars, electronic organ– and repeated lines.

The hymns: No One Ever Cared For Me Like Jesus – Then Jesus Came – In The Garden – When I Come To The End Of The Road – I Need Jesus – That The World May Know – The Old Rugged Cross – He Lives – Beyond The Sunset – Living For Jesus.

The sound is full and clean and the basic melodies are as recognisable as the hymns themselves are familiar, but individuals will vary in their reaction to the mod. get-up. On the happy, boisterous hymns the format sits naturally enough but, when "The Old Rugged Cross" receives the same treatment, I wonder whether the tune merchants gave even the slightest thought to the words.

Provided you don't suffer hang-ups of this nature, the Paul Johnson Singers would go over well enough in the average mixed-family situation. (W.N.W.)

★ ★ ★

CLOSE TO THEE. George Beverly Shea. Stereo, RCA Victor APL1-0471.

If evidence is needed of the popularity of Gospel singer Bev Shea, one would need only to recall the number of albums he has released over the years. I remember counting up about fourteen on an earlier occasion and there have been others since then. Although recorded at the Nashville studios of RCA, I get the impression that the vocal and orchestral backing is less generous than usual, throwing a heavier load on a soloist who is no longer a young man. The titles: Close To Thee – Every Time I Feel The Spirit – Hope In God – Reach Out To Jesus – Whispering Hope – Where Could I Go – By And By – He's Everywhere – The Lord's Prayer – Fill My Cup, Lord.

The quality is a trifle patchy, generally clear on the voice but with a suggestion of roughness here and there on the backing orchestra and chorus. There have been better Bev Shea albums but, if you already have them and you're a Bev Shea fan, then the above reservations certainly won't stop you enjoying the contents of this new one. (W.N.W.)

Instrumental, Vocal and Humour

REVERIE. The Royal Liverpool Philharmonic Orchestra World Record Club Stereo WRC S/4799

This delightful record is most aptly named, for it certainly creates a mood of reverie. There are eight tracks covering a range of classical composers. From Chopin we have The Nocturne from "Les Sylphides"; from Massenet the Meditation from "Thais"; Nocturne by Borodin; Nocturne from "A Midsummer Night's Dream" by Mendelssohn; Adagio in G minor for strings and Organ by Albinoni-Giazotto; Gluck's Dance Of The Blessed Spirits; Pavane By Faure; and from Gounod we are offered the Judex from "Mors et Vita".

The quality and stereo image are excellent, making the record an excellent buy at club prices. (N.J.M.)

★ ★ ★

MELODY FAIR. The Soundtrack Orchestra. Quadraphonic, Mastersonic (W&G) WG-35/Q/5626.

Another one from Melbourne-based W&G, this album comes originally from the Nippon Columbia Co, Japan. Perhaps hinting at the shape of things to come, it has been encoded according to the RM matrix system and prominently marked "QX", which isn't all that far in practice and terminology from "QMX" which Nippon Columbia have used to describe their new UD-4 discrete format (See "HiFi News" March issue). Sufficient to say that it decodes very nicely through the E.A. Stereo 2/4 adaptor.

The music itself is just about as smooth and easy on the ear as music can be and the film theme selections add their own attraction: Melody Fair – The Marriage Waltz – Alfie – Both Sides Now – The Cad – The April Fool – Swedish Love Story – The Red Tent, Main Title – Love Story – We Love You Underground – Romeo and Juliet – The Particular Lesson.

Technically, the sound is very smooth due, in part, so the jacket claims, to the American developed "Mastersonic" cutting technique. Very smooth; very pleasant! (W.N.W.)

★ ★ ★

LA HARPE DES ANDES. Gerardo Servin. Barclay stereo L 35237.

The harp of the Andes is played by Gerardo Servin and is backed by guitars and percussion. Servin plays in virtuoso style with plenty of glissandos to make the music really bright. Sound quality is excellent, so we can recommend this disc.

Fourteen tunes are featured: El Tren Lechero–Amalia Rosa–La Canahuatera–Reyes Morenos–Costa Brava–La Troppilla El Triunfo–El Negrito Del

Reviews in this section are by Neville Williams (W.N.W.), Harry Tyrer (H.A.T.), Leo Simpson (L.D.S.), Gil Wahlquist (G.W.) and Norman Marks (N.J.M.).

Batey—Chacareando—Hay Quien Pudiera —Luna De Maracay—Mitacunami—Palo, Palo, Palito—Nueva Piel—El Canaveral. (L.D.S.)

★ ★ ★

YE OLDE MOOG. Synthesonic Sounds, arranged, conducted and produced by Mike Batt. Stereo 4D series, Astor SPLP-1429.

If you want to know more about this album, you'll look in vain for jacket notes. I would judge it to be a mix of sounds from traditional instruments and from a Moog synthesiser but there's plenty of room for argument about what is which, and who does what. The sound is clean and varied but my own reaction is that sixteen tracks of Moog is a bit much for straight listening. A few tracks at a time would go down much better.

Going to make up "Ye Old Moog" theme is: English Country Garden—Riddle Song—Scarborough Fair—Ash Grove—Drunken Sailor—Danny Boy—Morning Has Broken—Oh No John—Strawberry Fair—Streets Of Laredo—Amazing Grace—Early One Morning—Greensleeves—Cockles and Muscles—Loch Lomond—House Of The Rising Sun.

The endorsement "Stereo 4D" could mean conventional stereo, quadraphonic or compatible; the label gives no hint. All I can say is that it sounds okay either way—clean, different, and pleasant a few tracks at a time. (W.N.W.)

★ ★ ★

CHARLIE McCOY. The Nashville Hit Man Monument Records L35305 Festival release.

I automatically except high technical quality to come from the various studios in Nashville and this collection of numbers with a mainly western theme certainly shines, with clean, driving bass and a generally superb sound.

About the only person not listed on the sleeve notes must be the tea lady. The eleven tracks are: Silver Threads And Golden Needles — Help Me — Fireball Mail — The Way We Were — Keep On Harpin' — You Win Again — Boogie Woogie — I Can't Help It — Heart Over Mind — Ruby — Let Me Be There. The cover photo depicts a scene reminiscent of an underworld 'hit' of the prohibition era, with bodies strewn around. Even the feet get a credit! There is lots of good steel guitar and harmonica playing as well as a very good rythm section, in all a very enjoyable record. (N.J.M.)

★ ★ ★

JACK DANIEL'S ORIGINAL SILVER CORNET BAND. Paramount Stereo L 25115

If you fancy some whimsical, nonsensical tunes played by an amateur brass band of another era, then I cannot suggest a better album than this. A great deal of time and money has gone into the re-creation of the original Jack Daniel's Silver Cornet Band from Lychburg, Tennessee, and it has been thoroughly worthwhile. Recording quality is generally good though a trifle edgy at times and there is some surface "prickle" and tape hiss. But unless you're very fussy in this regard, it can be recommended.

Some of the tunes presented on the disc are: The Bear Went Over The Mountain — Hail Hail The Gang's All Here — Ta Ra Ra Boom Te A — The Whistler And His Dog — Listen To The Mocking Bird — Shenandoah — Row, Row, Row — Waiting For The Robert E. Lee. (L.D.S.)

MY HEART REMINDS ME. The Paul Robinson Players Good Earth Records WG/S5611 W&G Release.

To be honest, I had never heard of this group of musicians; more to my sorrow as they produce a very pleasing sound, something akin to a scaled down Mantovani. They make their tuneful way through ten fairly standard numbers as follows: A Man Without Love — Somewhere My Love — Ode To Billy Joe — Softly As I Leave You — The Girl From Ipanema — Autumn Concerto — The Shadow Of Your Smile — I've Grown Accustomed To Her Face — By The Time I Get To Phoenix — I Left My Heart In San Francisco.

The sound quality is excellent and the stereo facility is skillfully used, making an ideal record for dinner background or dancing. (N.J.M.)

★ ★ ★

THE ROYAL TOURNAMENT 1974 — "TRAFALGAR" Columbia Stereo, SCXO 6568.

I cannot imagine who in Australia would want a recording of a military pageant held in London, but if you have a place in your collection for a record of this type, this one is certainly exciting enough and well recorded. Various British military bands provide a high standard

Recommended for your quadraphonic collection

BIG BAND HITS OF THE 30's. Volume 2. Enoch Light and the Light Brigade. Quadraphonic, Project 3 (Festival) LQ-35,308.

Technically, this new recording by Enoch Light is right out of the top drawer. Recorded originally on 35mm magnetically coated film, it is completely free from any suggestion of background noise, peak overload or limitation on frequency response. But, curiously, with all the emphasis on technical excellence, there is no hint on the jacket of the matrix format. I simply played it as SQ and it sounded fine!

As to the musical content, Enoch Light researched the original big-band arrangements and set out to recreate them, featuring those of his musicians who, by talent and past association, were best qualified to cope with the leads.

Numbers and arrangements featured are as follows: Benny Goodman: Stardust, Bugle Call Rag, King Porter Stomp. Glenn Miller: Little Brown Jug, American Patrol. Duke Ellington: Caravan, Solitude. Artie Shaw: What Is This Thing Called Love, Softly As In A Morning Sunrise. Clyde McCoy: Sugar Blues. Tommy Dorsey: Boogie Woogie. Glen Gray: Smoke Rings.

Technically, musically, it's a beauty. Recommended. (W.N.W.)

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of band music and an exotic touch is provided by the drums of the Sri Lanka Police Reserve. A large part of side 2 is devoted to the main theme of the 1974 Tournament — "Trafalgar". Presumably the audience present on the occasion were treated to an impressive visual spectacle, but the sound only presentation has a considerable amount of interest when heard in conjunction with the sleeve note. (H.A.T.)

★ ★ ★

JERRY SMITH, RAG TIME. Interfusion, Harlequin series L 25153. Astor release.

Excellent ragtime piano playing with an occasional touch of 'boogie' style makes up this record with a dozen all-time piano hits. As the titles show, most of the tracks fall into the singalong category: Johnson Rag—The Old Piano Roll Blues—Baby Face—Ragtime Cowboy Joe—Music Music Music—Give The World A Smile—Rattle Trap—12th Street Rag—Down Yonder—Red River Valley—Swanee River—Laura's Living Room. The quality presents no problems and the backing group does a competent job to make up an enjoyable party record. (N.J.M.)

★ ★ ★

THE GREAT RAGTIME CLASSICS. Paul Hersh and David Montgomery. RCA Victrola stereo AVL1-0364.

To listen to this album is to learn the meaning of the expression "tickle the ivories". The arrangements for dual ragtime pianos (hony-tonk?) are very lively and make cheerful listening. For the finicky listener there is an edginess to the sound which tends to irritate after a short while. With this reservation, it's still a good album.

Rag titles are as follows: Bohemia—The Music Box—Swipsey Cakewalk—Shreveport Stomp—The Entertainer—Maple Leaf Rag—Wall Street Rag King Porter Stomp—Grampa's Spells—Castle House Rag—Cleopatra Rag. (L.D.S.)

★ ★ ★

DUTCH SWING COLLEGE BAND. 25th Anniversary Concert Parlophone PCSO 7572 Stereo EMI Release

The Dutch Swing College Band has been a part of the European Jazz scene since it was formed in 1945 and their professional, crisp Dixieland brand of playing has earned them a loyal following right through the world. This record was made during a concert and ball to celebrate the Band's 25th anniversary in 1970 and includes these titles: Way Down Yonder In New Orleans — There'll Come A Time — Strange Peach — Silver Jubilee Blues — King Porter Stomp — Livery Stables Blues — Henry Hudson — Yesterdays — I'm Crazy 'Bout My Baby — Mississippi Mud — Rose Room — Rose Of The Rio Grande.

The quality is really good; a must for Dixieland fans! (N.J.M.)

★ ★ ★

THE MAN WITH THE GOLDEN GUN. Movie Sound Track United Artists L 35370 Festival Release.

My thoughts on sound track records I have made known before: unless you have seen the film and are really crazy about it, why buy a souvenir of some of the music? This record has the redeeming grace of technical brilliance that puts it in the demonstration disc class to show off your new electronic furniture. All the tracks carry the main theme, with instrumental and tempo changes to break the monotony.

Try to listen before you buy. (N.J.M.)

★ ★ ★

FAMILIAR FAVOURITES. Joseph Seal at the Wurlitzer. Stereo, Astor GGS-1441. Also on cassette.

Joseph Seal is certainly making his presence felt with albums on the pipe Wurlitzer: an old-time organist on an old-time instrument, playing music in the traditional theatre manner. And the numbers on this disc are among those which were often performed by way of a change from the usual round of current hits and music hall favourites: Knightsbridge March — Beautiful Dreamer — Ballet Egyptien No. 1 — Chanson De Matin — Valse Caprice — Thrill Of The Pipes — Trees — Beautiful Spring — In A Monastery Garden — Can-Can (Orpheus In The Underworld).

Listen carefully and you'll notice a certain amount of auditorium noise in the background. And, here and there some of the detail suffers as pipes come in a split second late or chop off a fraction too soon. For these and other reasons many don't like the big cinema organs but, if you're one of the large band of enthusiasts, you enjoy this latest offering from the well known English organist recorded, I would assume, at the ABC Theatre, Kingston on Thames. (W.N.W.)

★ ★ ★

THE WORLD'S GREATEST OPERATIC ARIAS. Harry Secombe, tenor, with orchestra directed by Peter Knight. Philips Stereo, 6308 203.

Harry Secombe is a first rate comic and entertainer who also happens to have a fine tenor voice, but this does not qualify him for a purely operatic program. There are numerous discs of this kind recorded by the leading tenors singing today, and Harry Secombe simply cannot compare with them in interpretative depth. Therefore, if you need a good recording of the great arias recorded here look elsewhere. If you want a disc to show

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SPEAKER KIT: (less cabinet) comprising 1 8-30 speaker, 1 6J speaker, 1 Philips dome tweeter, 1 1mh. inductance, 1 8 mfd. & 1 4 mfd. polyester condenser, 1 3" & 1 6" tube, innabond & speaker silk, plans for cabinet.

$40.00. Reg. Post & Packing $3 Extra.

CABINET AVAILABLE

— MAGNAVOX PHILIPS 2 WAY —

AS FEATURED IN JAN 75 ELECTRONICS AUST. COMPLETE KIT OF PARTS. Less cabinet.

$35.00

post & packing $3.00 extra.
CABINET AVAILABLE.

— PHILIPS 2 WAY —

AS FEATURES IN MARCH 75 ELECTRONICS AUST. COMPLETE KIT OF PARTS. Less cabinet.

$32.00

post & packing $3.00 extra.
CABINET AVAILABLE.

24 WATT R.M.S. HI-FI SYSTEM $229.00

EXPO 1212 AMPLIFIER 24 WATTS R.M.S. (12 watts r.m.s. per channel) IN WALNUT FINISHED CABINET WITH HIGH FILTER, LOUDNESS CONTROL & TAPE MONITOR. FREQUENCY RESPONSE 20 TO 25,000 CYCLES, DISTORTION BETTER THAN 0.5% AT FULL RATED OUTPUT. GARRARD 6-300 CHANGER WITH SHURE MAG. CART. WITH BASE & COVER. TWO FOUR WAY SPEAKER SYSTEMS; TWO PHILIPS 8" & TWO PHILIPS TWEETERS IN EACH SYSTEM. WALNUT FINISH. (regret no mail orders).

NEW PLAYMASTER 143 AMPLIFIER

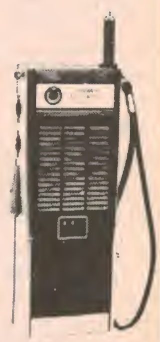
As featured in Sept & Oct. issues of Electronics Australia.

$72.00

Complete kit of parts including all transistors for this high fidelity 25 watt amplifier, silver anodised panel with black lettering and matching silver anodised knobs & special transformer with electrostatic shield. Reg. post & packing $3.00 extra.

De luxe version of the 143 amp. with high & low filters as used in the 140 playmaster plus loudness control **$7.80 extra.**

NEW N.C. 310 DELUXE TRANSCEIVER



For 27240 or 27880 Khz operation (state which required) with switch position for additional two-channels tone call signal, noise squelch control, circuit contains 13 transistors, diode and thermistor. Transmitter stability crystal controlled .005 Ceramic filter. Aerial 9 section telescopic powered by 8 1.5v UM3 batteries. Range up to 10 miles depending on conditions. Battery check meter. Attractive and durable die cast case with provision for external speaker, aerial and power supply. **$49.50**
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CLASSIC RADIO

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PHONES 798 7145, 798 6507

the versatility of genial Harry Secombe, singing fine music, this could well be worth your attention. The titles include such well known tenor arias as Flower Song from "Carmen" — Strange Harmony of Contrasts, and When the Stars were Brightly Shining, both from "Tosca" — woman is Fickle from "Rigoletto" — None Shall Sleep from "Turandot" — On with the Motley from "I Pagliacci" — and others from "Manon Lescaut", "L'Africana", "Martha", "L'Arlesiana", "Fair Maid of Perth". The recording is of satisfactory standard. (H.A.T.)

★ ★ ★

ALFONS BAUER. Sonic stereo 9075

The manufacturers of Astor and allied record labels are doing themselves a disservice in the marketing of this record. They could have at least translated the track titles and then perhaps provided a few explanatory notes to sell what is a very well recorded and thoroughly pleasant album.

Alfons Bauer is portrayed on the cover as a rather bemused gent in Austrian national dress and playing a zither. Accompanying him with piano accordion is an attractive lass also in national dress. They play some very lively and cheerful music with a suitable complement of yodelling on some tracks.

There is little point in listing the tunes played as they are all in a very foreign language. (L.D.S.)

★ ★ ★

SONGS SUNG BLUE (AND OTHER COLOURS). Val Doonican. Philips 6326 600 Stereo. Phonogram release.

I always enjoy Val Doonican's performances, whether on record or TV and this recent release from the Philips label only reinforces the view. Twelve of the top tunes of recent years make up the content: Sing—There Ya Go—It's Four In The Morning—Faces And Places—Amazing Grace—If You Could Read My Mind—Song Sung Blue—Spanish Eyes—Tie A Yellow Ribbon Round The Old Oak Tree—Sweet Caroline—Children—Oh Babe, What Would You Say.

The orchestra and chorus directed by Ken Woodman do a good job and, with good quality and sound, make an excellent buy for anyone that enjoys a ballad. (N.J.M.)

★ ★ ★

JUDITH DURHAM & THE HOTTEST BAND IN TOWN. Volume 2. Interfusion stereo L 35331.

Women's Libbers would be cheered to know that I find Judith Durham overpowering. Judy puts every last gram of effort into her songs on this album and the result is a sort of female Tom Jones. Add the big brassy accompanying orchestra and the result is unbearably loud with the volume turned anything above a whisper. Please sing a little more softly, next time!

Thirteen tracks are featured: Basin Street Blues—Papa If You Can't Do Better—The Man I Love—Nobody's Blues But Mine—The Hottest Band In Town—Coney Island Washband—Down By The Riverside—What'll I Do—Louisville Lou—It's Goin' To Be A Beautiful Day—The Entertainer—Chase Those Blues Away—On Revival Day. (L.D.S.)

★ ★ ★

FIRST IMPRESSIONS. Olivia Newton-John. Interfusion stereo L 35375.

Olivia Newton-John deserves to do well in her singing career. Her songs are well chosen and she sings them in a straightforward way that is refreshing to listen to after some of the garbage that is passed off as talent in popular music. On the other side of the coin, the sound quality on this disc is on the rough side. Let us hope that Olivia follows the lead taken by some other successful pop artists in demanding quality recordings.

Tracks include all her recent hits: If Not For You — Banks Of The Ohio — Winterwood — Take Me Home, Country Road — Amoureuse — Let Me Be There — I Love You, I Honestly Love You — Long Live Love — If You Love Me Let Me Know — What Is Life — If We Try — Music Makes My Day. (L.D.S.)

Books & Literature

Amplifier design

WIDEBAND VOLTAGE AMPLIFIERS, by C. W. DAVIDSON. Published by Intertext Publishing Ltd, Aylesbury, UK, 1975. Soft covers, 150 x 228mm, 112pp, many circuits and diagrams. Price in UK £1.95.

This is a brief but thorough little text, or more properly a monograph, on the operation and design of solid state amplifiers dealing with signals up to about 10MHz. It is intended for the undergraduate engineering student and for the practising design engineer and technician.

The flow of thought is logical, starting with basic principles of devices and circuits, and progressing through considerations of feedback, noise, distortion, output capabilities, etc, to various types of amplifier and their application.

The text is written in clear, concise language, and is well served by illustrations.

In short, while only modest in size and price, it gives just about all the detail information needed for any reasonably competent technician or engineer to design amplifiers using either discrete transistors (bipolar of FET) or ICs.

The review copy came direct from the publisher, with no information as to local price and availability. (J.R.)

Broadcasting

1975 WORLD RADIO AND TELEVISION HANDBOOK, 29th edition, published by World Radio and Television Handbook Co Ltd, Denmark, edited by Jans Frost.

The 29th edition is the biggest in size yet, with 440 pages crammed full of information on radio and television stations throughout the world.

In the past few years the major complaints have been the poor binding and the small print. The publication this year was printed and bound in the United States and uses a much bolder print.

The Handbook has come a long way since the first issue in 1947 with its 80 pages of information. Today radio listeners, professional monitors, broadcasters and the radio industry look on the World Radio Handbook as the complete directory of broadcasting and television world wide.

This year they should not be disappointed with the edition. It has many new features, and its information on stations in interesting countries like the USSR and Indonesia is the most comprehensive yet. The USSR details have been gathered mainly from monitoring.

As well as the details on every radio and television station under alphabetical country, listing schedules with power, frequency, addresses and other relevant information, this issue includes articles on the New Plan of Long Wave and Medium Wave, Solar activity in 1975, International regulations of the Broadcasting Service, How will Shortwave reception be today, and other articles on similar lines. At the back there is a full list of every station in order of frequency, so that cross reference is available.

As one who has handled the Handbook since its first edition, and watched the growth of this publication into the only reference manual of its type, and with my understanding of the work in-

volved in contacting thousands of stations for information, I can only express the gratitude of listeners everywhere to Jans Frost for another excellent edition.

The Handbook is available from technical bookstores or from Arthur Cushen, 212 Earn Street, Invercargill, New Zealand from whom a free brochure is available. (A.T.C.)

Amateur radio

AMATEUR RADIO TECHNIQUES by Pat Hawker, G3VA, 5th edition. Published by the Radio Society of Great Britain. Light card cover 245 x 185mm, 304pp, many circuits.

Now in its 5th edition, Pat Hawker's "Amateur Radio Techniques" is becoming something of a tradition in the field of amateur radio. For those who are unfamiliar with it, the author stresses that it is in no sense a textbook of radio theory, although it does, in fact, contain a lot of helpful discussion. It aims rather to be a companion volume providing hundreds of practical ideas and circuits to supplement normal theoretical study.

For the most part, the material has been adapted from items prepared for publication in the "RSGB Bulletin" (now "Radio Communication") so that its authenticity and relevance to the amateur scene is never in doubt.

The material has been grouped under general headings as follow: Semiconductors; Components and Construction; Receiver Topics; Transmitter Topics; Audio and Modulation; Power Supplies; Aerial Topics; Fault Finding and Test Units; Appendix; Index.

For those familiar with earlier editions, the natural question is how much of the material is new. The publisher's answer is: "... a considerable amount, in addition to revision and expansion of many sections." Those with a fifth (1974) edition may conceivably debate the investment but readers with older editions should be in no doubt. There really is a lot of material in Pat Hawker's book.

Our copy came direct from the publishers but supplies should be available by now through technical bookshops. (W.N.W.)

New Products

General Electric TC20T1 colour receiver

One of the latest colour TV sets to appear on the Australian market is the General Electric model TC20T1, marketed by General Electric-Kirby Appliances Ltd. It uses a 500mm (20in) picture tube and features an "instant on" facility, whereby both picture and sound are available immediately the set is switched on.

In greater detail the tube is a 110° deflection type, with a delta gun configuration and a black matrix screen. It is designed to present a correct 3 to 4 aspect ratio picture.

The 500mm tube would seem to be a good compromise between size and cost. As a guide, it is somewhat wider (406mm) and higher (304mm) than the old 17 in screen. Add to this the straighter sides, sharper corners, and correct aspect ratio and the result is a very satisfying picture area.

The cabinet measures 639mm x 448 mm x 469mm (W x H x D) and the complete set weighs 34kg (75lbs). The model submitted to us was finished with a teak pattern vinyl covering with a chrome surround on the front. It was well finished and had considerable eye appeal, particularly for the ladies.

The set is fully isolated from the mains, using a double wound 50Hz transformer, has a 13 channel tuner, uses a PAL-D (delay) circuit, and in all other respects conforms to the ABCB standards.

The tuner is equipped to take either 300 ohm ribbon or 75 ohm coax. It is fitted with a memory type fine tuning control, whereby the control is pushed in to set the tuning, after which this setting is selected automatically.

The "instant on" feature is achieved by running the picture tube heater continuously, at a reduced voltage. When the remainder of the set is switched on and full heater voltage restored, it requires only about one second for the heater to reach operating temperature.

While this may sound like a gimmick, it proved more convenient in practice than one would imagine. More importantly, the makers claim that this actually increases the tube life. Heater failure is normally caused by the repeated expansion and contraction associated with the heating and cooling cycles. By reducing changes in temperature to a minimum the risk of failure from this cause is also minimised. An additional switch allows the set to be switched off completely during holidays, etc.

The set submitted to us was taken at random from stock and delivered in its original packing. It was simply unpacked and connected to mains and aerial without adjustment of any kind. It produced first class pictures immediately, the convergence being well within tolerance.

Subsequently some herringbone pattern was noticed on channel 2, but we had been forewarned about this, and adjustment of the AGC control was all that was needed to control it.

The set has ample reserve of brightness, contrast, and colour intensity—more than could be used in most cases—and gives good results even in well lit rooms.

The set is made up from 11 modules, all of which may be replaced without the need for a soldering iron. General Electric are providing a board exchange service for dealers not equipped to repair their own boards. On the other hand, the boards are of open construction and readily repairable. The set carries a 90 day warranty and the picture tube a 12 month warranty.

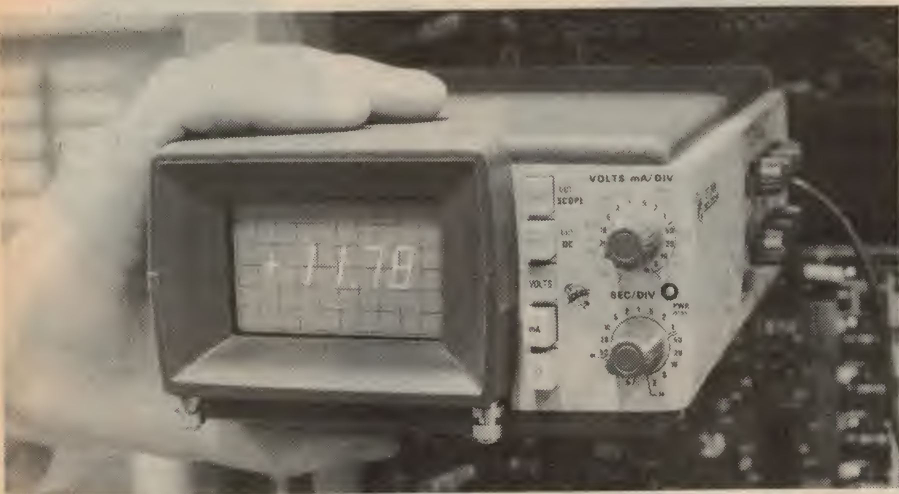
The attractive styling of the General Electric colour TV set is seen in this picture. A combined "on-off" and volume control is alongside the channel selector, and the brightness, contrast, and colour controls are slide types alongside the speaker grill.

The convergence controls, 14 in all, are mounted on a sub-panel near the top of the cabinet. It is designed to be easily demounted and placed on top of the cabinet so that the technician can face the screen while working.

We had the opportunity to use the set in a typical domestic environment over a period of several days, and our reaction is that it appears to be an excellent set in its size class. On live material and good quality tapes it produced pictures which can only be described as superb—and this with virtually no setting up adjustments of any kind.

Recommended price is $669.00 without a stand. A mobile stand, on castors, is available for an additional $30.00, making the total price $699.00. (P.G.W.)

Portable DMM / CRO combination



This new Tektronix instrument measures only 7.6 x 13.2 x 22.6cm, and weighs only 1.7kg. Yet it combines probably the two most useful measuring instruments of modern electronics: an oscilloscope and a digital multimeter. In addition, it runs from an internal, rechargeable battery and is thus truly portable.

Designated the model 213, it is ideal for precision servicing and field measurements. As a DMM, it provides DC and AC measurement ranges from 0.1V to 1000V, DC and AC current ranges from 0.1mA to 1A and resistance ranges from 1k to 10M. The AC ranges include a true RMS measurement capability, making it suitable for non-sinusoidal measurements.

In oscilloscope mode the 213 provides calibrated deflection factors from 20mV/div to 100V/div at DC-1MHz bandwidth, with an extension down to 5mV/div at 400kHz bandwidth. Current waveforms can also be displayed easily, with deflection factors from 5uA to 100mA/div. Sweep rates are from 2us to 500ms/div, with a variable magnifier providing up to 0.4us/div.

Readout for both DMM and CRO functions is via the CRT, with a 3 x 5cm screen. The 3½ digit DMM display occupies an area 1 x 4cm, giving easy readability.

Enquiries to Tektronix Australia Pty Ltd, with offices in each state.

"Zippy" boxes

To dress up those small projects without spending too much money, Dick Smith Electronics can supply these "zippy" boxes. The boxes themselves are moulded in ABS plastic, and normally come complete with a flush fitting aluminium panel, attaching via four self-tapping screws. There are two sizes, UB1 at 15 x 9 x 5cm (price $2.00) and UB3 at 12.5 x 6 x 4cm (price $1.65). Optional alternative panels are available.

Enquiries to Dick Smith Electronics at 162 Pacific Hwy, Gore Hill 2065.

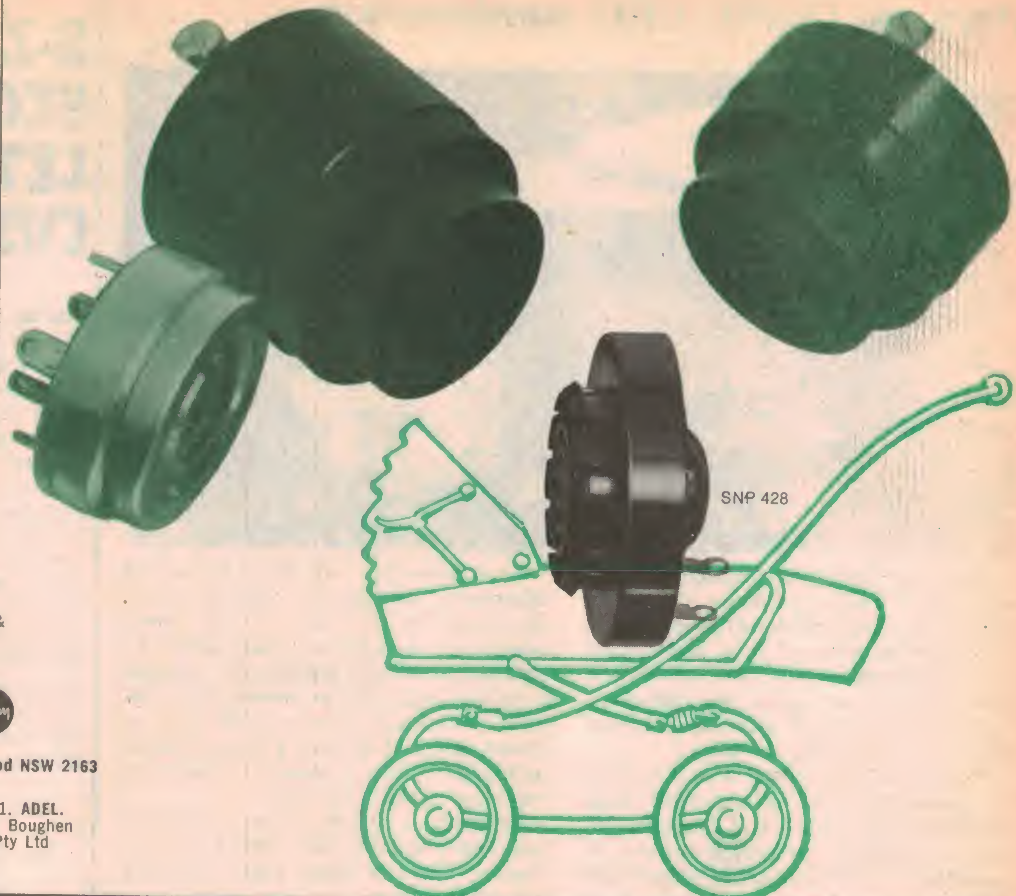
Flyback transistors

Finding replacement horizontal output transistors for imported solid-state TV receivers can present problems. Those involved in the servicing of such equipment may therefore be interested to know that Paris Radio and Electronics have good stocks of the type 2SC643A, an NPN silicon device with Pt rating of 50W, BVceo rating of 800V, BVcbo rating of 1500V, and Ic rating of 2.5A. Hfe range is 7-50 at 2A. With these ratings it should be suitable for replacement purposes in many receivers.

For further details on these and other components handled by Paris Radio, readers should contact them at P.O. Box 380, Darlinghurst 2010.

BIRTHS

SONALERT (Plessey). — February, 1975. To the Professional Components Division, a baby electronic signal with a big voice. Weight ½ oz. (also less than 21 mm thick). Eagerly welcomed by big brothers Mini Sonalert, SC 628 Sonalert and SC 628P Sonalert. This low silhouette newcomer is seeking a good home in automotive, appliance and entertainment equipment. Very lovable, will snap-in fit into 27 mm panel hole with greatest of ease.



"Sonalert" is a registered trademark and is manufactured by P. R. Mallory & Co. Inc., U.S.A.

PLESSEY

Plessey Australia Pty Limited
Components Division Box 2 PO Villawood NSW 2163
Telephone 72 0133 Telex 20384

MELB. Zephyr Products Pty Ltd 56 7231. **ADEL.** K. D. Fisher & Co 223 6294. **BRIS.** L. E. Boughen & Co 70 8097. **PERTH** H. J. McQuillan Pty Ltd 68 7111. **N.Z.** Henderson (N.Z.) 6 4189.

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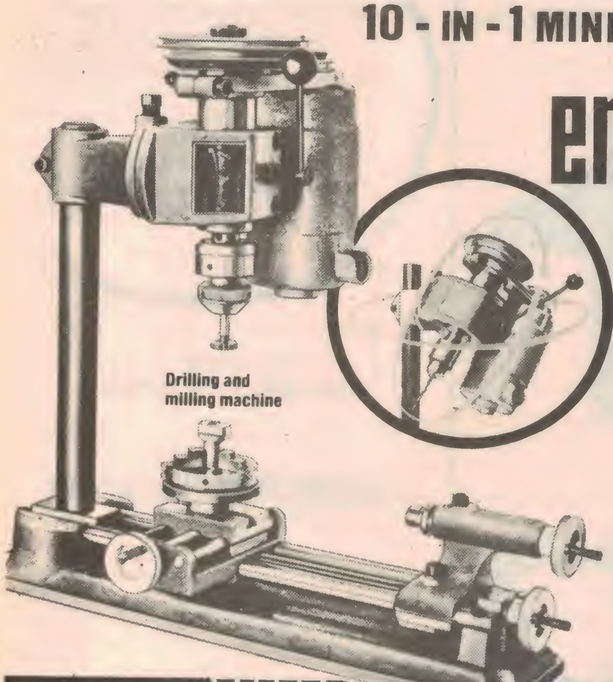

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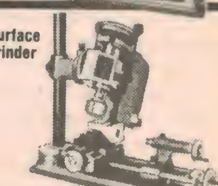
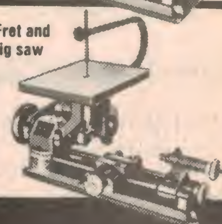


Circular saw

Fret and jig saw



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NEW PRODUCTS

Photo-etched panels

Pictured above is a selection of photo-etched front panels for several recent EA projects. Included are panels for the Playmaster 140, 141, 142 and 143 amplifier projects, the Slow-scan TV Monitor, and the Playmaster 144 Stereo Cassette Deck.

Interested readers should contact Wardrope and Carroll Fabrications Pty Ltd, PO Box 330, Caringbah, NSW 2229.

New plastic case range

Manufactured by A & R Soanar is this new range of high impact plastic cases, available in a variety of colours. Of modular design, the new cases feature three sets of interior slots for printed circuit card mounting, together with a rear fourth slot for mounting an additional panel (bracket, heat sink etc).

Other features include integral feet, and generous ventilation slits for cooling heat generating components. Interior dimensions are 120 mm x 120 mm x 60 mm.

Write to A & R Soanar Electronics at the address given elsewhere on this page.

Degaussing wand, battery charger from A & R Soanar

An essential part of every colour TV serviceman's tool kit is a degaussing wand, and this requirement is taken care of by the recently released XT8150 Degaussing Wand from the A & R Soanar Electronics Group. The new servicing aid is designed to demagnetise colour TV receivers which have become magnetised due to the earth's magnetic field, or some other extraneous cause.

A magnetised colour TV set is characterised by distorted colour balance and loss of colour saturation. These defects cannot be corrected for by use of the manual controls.

In use, the Degaussing Wand is simply pointed at the centre of the picture tube from a distance of 30-50 mm, switched on, and then gently moved with a circular motion of the wrist to trace the perimeter of the tube. The wand is then slowly withdrawn to a distance of 3 metres or more from the set, and switched off.

Also just released by A & R Soanar Electronics Group is the PS241 Nickel Cadmium Battery Charger. This unit is designed to charge heavy duty nickel cadmium batteries of the type used in emergency lighting systems, portable TV sets, amplifiers, electronic flashguns, electric tools, and the larger types of portable radios, electronic calculators, and tape recorders.

The PS241 is a constant current unit capable of charging 1-10 cells in series simultaneously. The unit is provided with a switch for selecting six charging rates between 22 and 600mA. Output voltage is 15VDC.

For further information contact A & R Soanar Electronics Group, 30 Lexton Road, Box Hill, Victoria 3128.

At top is the XT8150 Degaussing Wand, while directly above is the PS241 Nickel Cadmium Battery Charger. The battery charger is housed in A & R's new plastic case, featured elsewhere on this page.

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- Ideal for carrying into lecture halls for business presentations, for visual learning techniques, installing in shops as a deterrent to shoplifting, use at home to keep an eye on children playing, use in factory or warehouse to check incoming and outgoing goods or for observation of progress of production line etc, etc.

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- Fully equipped with Automatic Gain Control (AGC). Minimum required light is only 40 lux (4 footcandles). Suitable for security and surveillance.
- Picture and sound transmitted by simply depressing the interphone button. Picture and sound hold for 40-60 seconds, then automatically cut out.
- Tremolo Call System for 2-way conversations.
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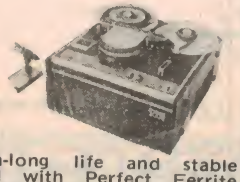

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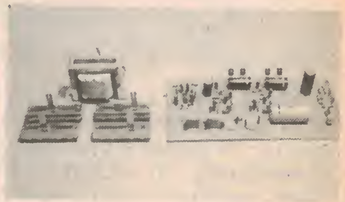
Kit includes transformer, labelled and numbered P.C. Board, all Resistors and Capacitors, 4 pages instructions.



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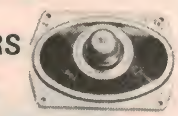

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8-30 8 Ohm	$16.50
3TC 8, 15 Ohm	$3.75
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1" Philips Dome, 8 ohm	$9.00

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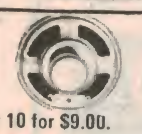

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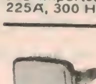
Popular replacement speaker for local and imported transistor radios. Model 225A, 300 Hz to 5 kHz.

5 inch T.V. TUBE



Brand new, sealed in manufacturer's carton
SPECIAL PRICE
$11.95.

Ideal for servicemen, amateurs and experimenters. Specifications:— Electromagnetic deflection, 70 deg. angle, filament 12 Volt 70mA, Anode voltage 8KV at 50µA, 2nd grid voltage 300V, 1st grid cut-off voltage -25V, electrostatic focusing, size 5½" x 4" x 7" long.

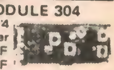
Price $11.95. (plus $1.00 registered post)

A limited quantity of yokes is available to suit above T.V. tube. **Price $7.50**

MINIATURE TUNING CAPACITOR

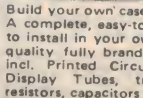
Most popular type suit imported radios. Size ¾" x ¾", 200pf per gang with inbulld trimmers, ☐ $1.00 ea. or 10 for $8.00.

DE-LUXE TUNER MODULE 304



A high sensitivity 4 transistor AM tuner with tuned RF amplifier and two IF stages for extra selectivity and sensitivity. The Module is ready assembled and operates from 9V DC at approximately 3MA. A permeability type tuner and push-button On-Off switch are supplied together with circuit and application diagrams. As the module may be used with a ferrite road type aerial OR an external wire type antenna, it is ideally suited to car, portable or home use. Size 5½" long x 1½" wide x 7/8" deep. Ferrite rod aerial $1.25ea. **$12.99** ☐

DIGITAL CLOCK KIT 4 DIGIT "NIXIE" DISPLAY $45.00



Build your own case!

A complete, easy-to-assemble kit ready to install in your own cabinet. All top quality fully branded, full spec. parts incl. Printed Circuit Board, Mullard Display Tubes, transformer, I.C.'s, resistors, capacitors etc.

VHF TRANSISTOR T.V. TUNER

12 Channels

A high sensitivity transistorized T.V. tuner suit Australian Stations. Operates from 12 V D.C. and output goes to IF section. Suit hobbyists, amateurs, T.V. servicemen etc. **$8.50 ea.** ☐

The Amateur Bands

by Pierce Healy, VK2APQ

IARU—Region III Conference

In March 1925, the concept of an International Amateur Radio Union was born. The aim was to coordinate worldwide amateur activities. Here, a half a century later, is a report on the third Region III conference held during March 1975 in Hong Kong.

During the past 50 years the IARU has flourished and is recognised as an official organisation by the International Telecommunication Union. It represents amateurs and their societies throughout the world.

The invitation to hold the third Region III conference in Hong Kong was extended by the Hong Kong Amateur Radio Transmitting Society (HARTS). The conference ran from the 4th March to the 8th March, 1975, and was held in the Lee Gardens Hotel, Hong Kong. All facilities for documentation of the proceedings were arranged by the host society.

Representatives of nine member societies, the president of the IARU, three directors and secretary of the Region III Association attended. They were:

IARU		
President	Noel Eaton	VE3CJ
Region III		
Directors	Michael Owen	VK3KI
	Tom Clarkson	ZL2AZ
	Kan Mizoguchi	JA1BK
Region III		
Secretary	David Rankin	VK3QV
ARRL	Dick Baldwin	W1RU
HARTS	George Flenner	VS6AI
	Bob McCurrach	VS6BL
	Dan Douglas	VS6DD
	Phil Wight	VS6DR
	Bob Norcross	VS6AF
	Mal Hamilton	VS6HI
	Drake Drakeford	VS6EK
JARL	Shozo Hara	JA1AN
	Sammy Saitoi (Dr)	JH3PJE
	Junko Kiso (Miss)	JR1ANP
MARTS	Ron Fisk	9M2CJ
NZART	Doug Gorman	ZL2IY
	Fred Johnson	ZL2AMJ
PARA	Joe Gonzalez	DU1JMC
	Ed Reyes (Dr)	DU1OR
	Jose Tupas	DU1JJT
RAST	Kam Chotikul (Col)	HS1WR
SARTS	Tan Lian Huat	9V1OD
WIA	David Wardlow (Dr)	VK3ADW
Observer	Maurice Caplan	VS5MC

The WIA also acted as proxy for the Radio Society Sri Linka. All HARTS representatives were not present at the same time and John YB7AAA in addition to being assistant secretary also participated in the discussions.

The conference was opened by an address of welcome by the HARTS president, George Flenner, VS6AI. The IARU president, Noel Eaton, VE3CJ then addressed the gathering, stressing the importance of the work to be done by the Region III Association. Particularly in regard to the approaching ITU—World Administrative Radio Conference at Geneva in 1979.

The officers appointed for the conference were:

Chairman	Michael Owen	VK3KI
Secretary	David Rankin	VK3QV
Asst. Sec.	John Van Lear	YB7AAA

Convenor of credentials committee David Rankin
Convenor of editorial committee Tom Clarkson ZL2AZ.

In addition to reports from the secretary, directors, and societies' representatives, the agenda contained a wide range of items for discussion. After preliminary discussions these were referred to working committees, whose reports, with some later amendments, became the official conclusions of the conference. Among these were:

Policy on Frequency Provisions:

1. Amateur activity is likely to have a world wide total of one million stations by 1982; the foreseen date of implementating the 1979-ITU-WARC decisions.
2. The increasing use of telephony justifies wider bands.
3. Increased frequency privileges should be sought as follows:
   a. The return of the 1800-2000kHz band.
   b. Eliminate sharing of the 3500-4000kHz band.
   c. Expand the 7MHz band to 7.0MHz to 7.5MHz and eliminate sharing with broadcasting services.
   d. Establish a new amateur band in the vicinity of 10.5MHz.
   e. Expand the 14MHz band to 14.0MHz to 14.5MHz.
   f. Establish a new amateur band in the vicinity of 18.5MHz.
   g. Expand the 21MHz band to 21.0MHz to 21.5MHz.
   h. Establish a new amateur band in the vicinity of 24MHz.
   i. All the above to be the same for all regions.
4. Article 41 of the ITU regulations should be amended to improve the official pronouncements describing the amateur service.
5. The amateur satellite service should merge with the amateur service so that there is freedom to use all bands in space communications.
6. Allocations should be sought in all parts of the spectrum up to 275GHz.
7. World wide allocations on 220MHz should be sought, if necessary on a shared basis.
8. While band plans are necessary in individual countries, coordination is not considered necessary or practical for VHF and UHF. But agreement will be needed to avoid conflict in space operations.

Societies urged to participate in a regionally coordinated intruder watch scheme. A WIA offer to nominate a regional coordinator was accepted. Greater occupancy of amateur bands to be encouraged.

To implement the policies, the proposals provide for:

1. Better communications between societies and administrations.
2. Better communications between societies.
3. Better communications between IARU headquarters and societies.
4. Coordination of travel liaison.
5. A meeting of Region III directors before the next conference.
6. A director from Region III should attend the Region II conference in 1976.
7. A booklet to be produced in suitable languages to advocate amateur radio throughout Region III.
8. Societies and IARU HQ to be urged to consider the conclusions of the Region III conference, in view of the personal discussions held there.
9. Societies to seek inclusion of an amateur on official delegations to the WARC or, alternatively, to have an amateur liaison officer on the delegation.

Financial Matters: A budget for three years (to the next conference) was prepared to carry out the Region III Association aims and the implementation of the policies set down. It was decided not to alter societies' subscription rates.

On this basis, in the third year, there would be a deficit of Aus. $6270. After considerable discussion the matter was resolved by a proposal from the Japan Amateur Radio League.

The JARL undertook to subscribe an additional amount, for each of the three years, of Aus. $2120. The payment was for the defence of frequencies used by the amateur service.

This very generous action of the JARL was emphasised by the conference.

Region III News: An offer by the JARL to publish a "Region III News" was accepted. Initially this will come out twice a year. Details are yet to be completed between the JARL and the secretary. Material for publication will be sought from member societies.

Region III Association Officers:

Directors	T. R. Clarkson	ZL2AZ
	M. J. Owen	VK3KI
	Tan Lian Huat	9V1OD
	Dr. S. Saito	JH3PJE
Secretary	D. Rankin	VK3QV

Next Conference: Invitations were extended by PARA (Philippines), RAST (Thailand) and NZART (New Zealand). The voting was Thailand, Philippines and New Zealand in that order. It is therefore proposed to hold the next conference in Bangkok, about October 1978.

LOCAL & OVERSEAS NEWS

IARU REGION I. Writing in the February, 1975 issue of the "Radio Communication", Roy Stevens, G2BVN, secretary Region I Division IARU, refers to that division's conference to be held in Warsaw commencing on 14th April, 1975; the same date as the first IARU conference held 50 years ago in Paris.

The Region I Division was formed 25 years later, on the 18th May, 1950. At the time that division consisted of 15 member societies; today there are 41 member societies.

Referring to the IARU, Roy writes:

"An international body, united in aim and purpose, is essential if amateur radio is to continue. No longer is the future controlled by the votes of those nations who have always held a traditionally friendly attitude towards the amateur service.

"Today, and in the future, ITU conference decisions will depend on the votes of nations who are, at the best, unco-operative with the amateur movement.

"The amateur service does not intend to be on the defensive. A logical plan for the expansion of amateur frequencies, in accordance with the conditions of the time, has already been considered in regional committee meetings. To be successful such a plan must be basically acceptable to many national administrations who will be prepared to support it at the ITU with positive votes.

"Only the IARU is in a position to prepare a plan and then to propagate it world-wide".

IARU REGION II. In the U.S.A. on 1st March, 1975, the basic fee for a new, renewed or modified-and-renewed amateur licence drops from $9 (US) to a new rate of $4 (US), equivalent to $2.95 (Aust).

In 1974 the FCC proposed to increase the fee to $10 (US) but, following a protest by the ARRL, the US Supreme Court ruled that the FCC had authority

Radio clubs and other organisations, as well as individual amateur operators, are cordially invited to submit news and notes of their activities for inclusion in these columns. Photographs will be published when of sufficient general interest, and where space permits. All material should be sent direct to Pierce Healy at 69 Taylor Street, Bankstown 2200.

to reclaim only part of its expenses, that part which represented the "value to the recipient" of the service received from the FCC.

Accordingly a new basic fee of $6 (US) was proposed. Again the ARRL protested, pointing out that there was no tangible benefit to the recipient, as he could not use his licence for pecuniary gain. Also, in view of that fact, such licences should be issued without fee.

The FCC has now clarified its interpretation of the Supreme Court ruling to mean "value of what the recipient receives, as its cost to the government", rather than the actual cash value to the recipient. ("QST" March 1975.)

(This is a very different approach to that taken in Australia by the PMG's Dept. in reply to the WIA protest against the 100% increase to $12 for an Australian amateur licence.)

AN E-M-E FIRST. What is believed to be the first SSB moonbounce contact between Australia and the USA, has been achieved by Chris Skeer, VK5MC on 144.107MHz.

Contact was made on the 30th December, 1974, at 1117GMT with W8PKY, initially on CW. A report R5-S4-T9 was sent by Chris and he received R4-S4-T9. On changing to SSB the reports were: sent R5-S4, received R4-S4. W8KPY was running 1kW to a yagi antenna and VK5MC 250 watts to a rhombic antenna. VK5NC and VK3AKC were visiting Chris at the time.

On 23rd February, 1975, at 0738GMT Chris worked K1WHS on CW. Reports: sent R4-S3-T9, received R3-S3-T9, also K2RTH at R4-S4-T9 and R4-S3-T9.

Eight stations in North America have now been worked via E-M-E by Chris.

At 1335GMT on the 22nd February on 1296MHz, Ron Wilkinson, VK3AKC worked PA0SSB on CW. Reports: sent R5-S3-T9, received R5-S2-T9.

On the 23rd February, 1975, between 1430GMT and 1525GMT Ron worked OZ9CR and between 1525GMT and 1542GMT again worked PA0SSB. In all cases the E-M-E signal report code "O" was exchanged. PA0SSB uses a 4 metre dish antenna with 1kW input and OZ9CR an 8.5 metre dish antenna, also 1kW input.

RADIO CLUB NEWS

TOWNSVILLE AMATEUR RADIO CLUB: The club will hold its second bi-ennial North Queensland Convention in Townsville over the weekend 26th and 27th July, 1975. Visitors from the cold southern states will be particularly welcome.

Registration forms and further details may be obtained from the NQC Convenor, TARC, PO Box 964, Townsville, Q. 4810. The closing date for registrations is 18th July. Registrations received up to this date will be eligible for a prize decided by ballot.

Further details will be given over the VK4WIA news broadcasts at 0900EST on Sundays. Intending visitors are invited to join the VK4WIT net on 3605kHz, each Sunday at 1945EST.

The official convention frequency will be channel 50 (146.5MHz) and a new repeater (channel 1) will be in operation by the convention date.

CENTRAL COAST AMATEUR RADIO CLUB: At the annual meeting the following officers were appointed. President—Bill Smith, VK2TS; Vice-president—Ray Wells, VK2ZSX; Secretary—Susan Wells; Treasurer—Leon Brett, VK2ZEC; Committee—Bob Leane, VK2ZLV; Ross Mudie, VK2ZRQ; Peter Ward, VK2YAA; Don Crutcher, VK2ZCZ; Stan Dogger, VK2ZRD, and John Tanner, VK2ZXQ. Public relations—Dick Maitland, VK2BBK.

With a favourable bank balance, a motion passed at the February meeting to transistorise the repeater can now be implemented. There is also further progress towards obtaining a new repeater site.

A refinement will be a Morse clock. As well as the call sign (VK2RAG) in Morse, as at present, it will also give the location and time when first activated. The time will also be transmitted at intervals while the transmitter is in operation.

In spite of the bad weather 475 people attended the 18th annual field day on Sunday, 23rd February, 1975.

All the field events were keenly contested and excellent prizes for the winners were donated by

various business houses. Several provided trade displays of the latest amateur equipment.

The club wishes to thank those who provided the prizes and displays, and all who attended and made the day such a success.

BLUE MOUNTAINS BRANCH NSW DIVISION WIA: The annual meeting was held on Friday night, 14th March, 1975, in the Springwood Primary School. The officers elected were:

President: D. Clift, VK2DC; Vice-presidents: N. Thyrd, VK2AUS and N. Walker, VK2ZNS; Secretary: R. Lopez, VK2BRL; Treasurer: A. Griffard, VK2AGN; Publicity officer, Rex Black, VK2YA; Catering officer, W. Moore, VK2HZ; Education officers, H. Smit, VK2BHS and J. Oxley, VK2YCO.

Preliminary plans were formulated for the 1975 Blue Mountains Branch field day and for an "outreach" demonstration of amateur radio to introduce the branch's activities to more people in the area.

Those interested in gaining an amateur licence are invited to join the classes each Friday night in the Springwood Primary School, at 8.00 p.m.

The branch has offered a book prize to the student who performs best during the year in the new electronic course at the Katoomba High School. This is being conducted by Brian Kleinschafer, of the science staff, on a three lessons per week basis. Branch members hope to provide the school with radio equipment and components.

ILLAWARRA BRANCH NSW DIVISION WIA: A moonbounce test with WA6LET using a 45 metre dish antenna was held on 22nd February, 1975. VK2AMW was operated by Charles Proctor, VK2ZEN and Roger Evans, VK2BRE. Signals were heard from WA6LET from 0800GMT to 0845GMT at 8dB above the noise, but repeated calls from VK2AMW were not acknowledged.

Work is proceeding at VK2AMW on the quarter wave filter in front of the receive preamp.

The Board of Senior School Studies has approved a proposed two unit course at the Wollongong Technical College for 5th and 6th forms.

This course is to provide a broad theoretical and practical introduction to electronics circuits, for students interested in electronics as a hobby or as a career.

High School students in 5th form may take this course for the Higher School Certificate. Other persons may also attend.

Enquiries should be directed to Bruce Carroll, VK2ZIC, School of General Studies, telephone Wollongong 299 9611 ext 271. Classes—6.00 to 9.00 p.m. Room 6, Science Block, Wollongong Technical College.

GEELONG AMATEUR RADIO-TV CLUB: Details of repeaters in Victoria appeared in the GARC Newsletter, March, 1975. This was the result of a repeater committee meeting held in the WIA rooms, Melbourne on 15th February, 1975.

Repeater standards:

a. Deviation + and − 10kHz.
b. Transmitter power (to suit area) 150W max.
c. FSK identification.
d. Tail length: silent—1 second long.
e. Timers 2½ minutes.

Call signs and channel locations:

VK3 — RAP Mt Arapiles	Ch. 1*
RAM Mt Alexander	2
RSH Swan Hill	1+
RMW Mt William	3
RMM Mt Macedon	6 or 7*
RML Mt Dandenong	1
RGL Mt Anakie	4
RLV Mt Tassi	2
REG Mt Sugarloaf	3*
RBA Ballarat	5*
RMA Mildura	4*
? Albury-Wodonga	4*

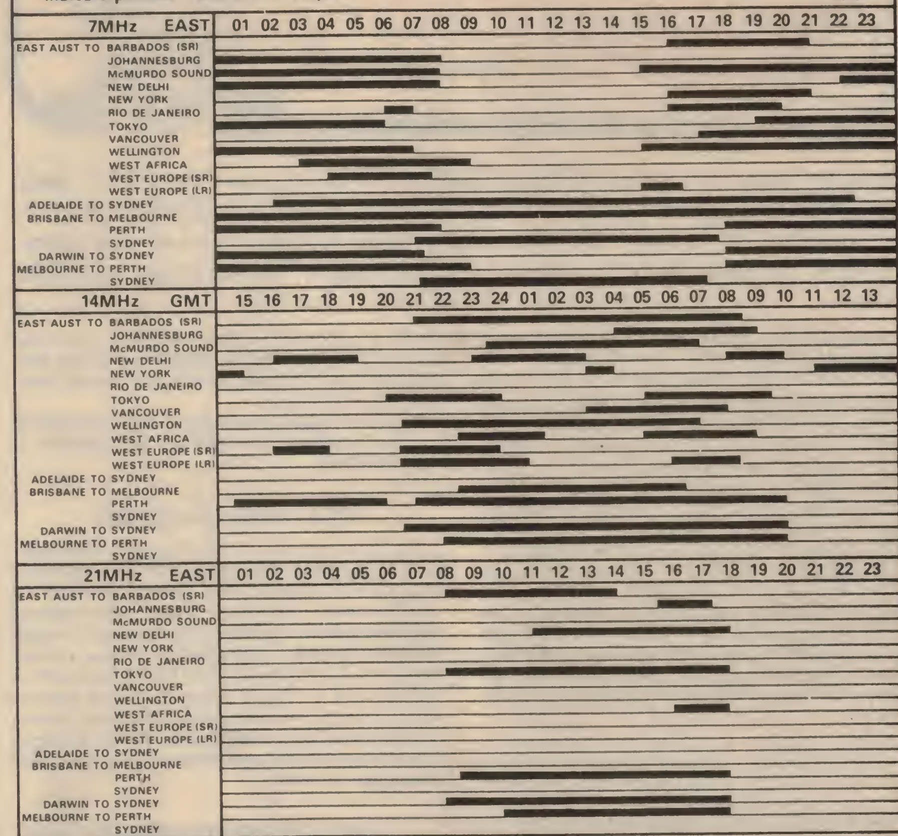
* Proposed; + pending licence.

Members of the Victorian repeater executive elected at the meeting were:

Chairman	Peter Linden	VK3BX
Vice-chairman	Peter Mill	VK3ZPP
Secretary	Ken Jewell	VK3ZNJ
Publicity officer	George Francis	VK3ASV

IONOSPHERIC PREDICTIONS FOR MAY

Reproduced below are radio propagation graphs based on information supplied by the Ionospheric Prediction Service Division of the Department of Science. The graphs are based on the limits set by the MUF (Maximum Usable Frequency) and the ALF (Absorption Limiting Frequency). Black bands indicate periods when circuit is open. 5.75



The GARC conducts a wide range of activities associated with amateur radio. For details write to the Secretary, PO Box 520, Geelong, Vic. 3220.

GOLD COAST RADIO CLUB: Material for a new repeater antenna has been received and construction is under way. A higher power final has been installed and reports are that the signal is being received a little better in the more difficult areas. One report came from Dalby around 200kM distance.

A GCRC net on 3650KHz at 8.00 p.m. on Sunday evenings is popular with listeners in southern states. Anybody, member or not, is invited to join in. Visiting the Gold Coast? Then let the club know through PO Box 588, Southport, Qld, 4215. Members will be pleased to see you.

UNIVERSITY OF NSW AMATEUR RADIO SOCIETY: The society held a successful demonstration of amateur radio during university orientation week. Several new members were recruited and a good start for 1975 seems assured. Contacts were made on all HF bands, including all states and a number of interesting overseas stations. The equipment was the club's FT101B and an 18AVT antenna on top of the Roundhouse.

After submitting an idea for a WIA educational hobby station on the FM broadcast band to the council of the NSW Division, the society has been asked to conduct a feasibility study.

The study will examine such issues as ownership, equipment, staffing, and finance. The society was also requested to submit the proposal to the WIA federal convention.

For information write to UNSWARS, Union Box 57, PO Box 1, Kensington, 2033 or call at the society's club room, Room 601, Electrical Engineering Building, University of NSW, Kensington.

WINDSOR YMCA RADIO CLUB: A radio club for high school students at the Windsor YMCA centre in Brisbane, was formed on 14th February, 1975. The club is jointly sponsored by the YMCA and the Queensland Division of the WIA.

First year membership will be limited to 50. Activities will range from building simple radio receivers to an amateur radio station. In 1976 the course will be expanded to cover the AOCP.

The WIA is providing a number of instructors to lecture on radio and electronic theory, job opportunities in electronics, amateur radio, satellites, digital computers and associated subjects.

Inquiries may be directed to the YMCA centre.

EDENHOPE HIGH SCHOOL RADIO CLUB: An enthusiastic group of students have formed a radio club. Their immediate aim is to study for their amateur licence. The long-term goal is to help others to do likewise.

Like all new clubs any assistance to help them to achieve their aims would be appreciated. The secretary is Tracey Evans, EHSRC, PO Box 117, Edenhope, Vic. 3318.

Shortwave Scene

by Arthur Cushen, MBE

Cyclone Tracy, which devastated Darwin on Christmas eve, 1974, also destroyed the Radio Australia Complex with its three 250kW transmitters on Cox Peninsula. The Commonwealth Government is now considering the best way to restore the service in the shortest possible time.

Initial tests have been made with low powered equipment (under 10kW) from Gnargara, 40km north-east of Perth. These tests were beamed to South Africa, Europe and Indonesia and, from early reports, the Australian Post Office is making evaluations. Other sites are being inspected, including areas as far north as Carnarvon.

According to the April issue of "Australian Post Office News", senior PMG technical advisers are against re-establishing the Darwin complex at its old level, due to its vulnerability to storm damage.

As a stop gap measure it is proposed that two transmitters, of 25kW and 100kW respectively, be purchased overseas and installed at Gnargara. Cost of the two transmitters and their installation would be about $2.9 million. If the scheme is approved without delay PMG engineers are confident that they could have them installed and working by late December.

A long term plan to replace the transmitters at Shepparton, Victoria, some of which have been in use since 1943, is also being considered. Such a move could involve a total expenditure of up to $45 million. In the present economic climate such a plan is likely to be treated as long term project, rather than one of urgency.

BRAZIL EXTENDS SERVICE

Radio Nacional at Brazilia, as well as operating the international service now broadcasts 24 hours a day with a relay of the internal service. According to the station the internal transmissions are on 6065, 9665, 11720 and 15445kHz, and the power on all frequencies is 10kW. These transmitters are located within the city limits of Brazilia.

The international service has been assigned 9605, 11780 and 15245kHz, at 250kW, and these transmitters are 50km from Brazilia. The station broadcasts in Portuguese at 1900GMT followed by German at 2000 and English at 2100GMT. At 2200GMT the program "A Voz do Brasil" is carried. The station address is: Radio Nacional De Brasilia, P.O. Box 07/0173, Brasilia, D.F., Brazil. The verification card shows a map of Brazil and the various states.

FINLAND INCREASES POWER

The Finnish Broadcasting Company is to be provided with a 250kW transmitter for world wide broadcasting, and this should be in operation next year. In the meantime, according to the New Zealand DX Times, Radio Finland currently has one 100kW, two 15kW and one 1kW transmitter at the Pori short-wave station. Also a 15kW transmitter relays the full home service on 6120kHz. There are 19 and 31 metre dipole antennas beamed to Europe, and a 25 metre antenna beamed to Mediterranean areas. The new 250kW transmitter will have full short-wave coverage and there will be a rotatable wide-band antenna covering all bands. However, the long term goal is to build a completely new short-wave station in Southern Finland.

At present Helsinki Broadcasts in English 0300-0330 and 1600-1630GMT, on 9550 and on 15185kHz at 1800-1830GMT.

Notes from readers should be sent to Arthur Cushen, 212 Earn Street, Invercargill, NZ. All times are GMT, add 9 hours for West Aust. Summer time, 11 hours for East Aust. Summer time and 13 hours for NZ Summer time.

VOA VIETNAM CLOSES

The Voice of America station at Hue, South Vietnam, closed earlier this year after being in operation for nearly ten years. The station operated on medium-wave, 760kHz, at 50kW. VOA Vietnam programs were in Vietnamese and beamed to North Vietnam. Reception was possible in New Zealand when 1YA Auckland was silent. The closing of VOA Vietnam and the many American Forces Vietnam network stations has removed an interesting source of broadcasts, particularly the key station in Saigon. Operating on 540kHz with 50kW, it was widely heard throughout the area.

ENGLISH FROM LISBON

Major changes have taken place in Portugal and these have been reflected in the short-wave service. Broadcasts of the Voice of the West have been cancelled and all transmissions are now conducted with the slogan "Emissora Nacional Lisbon". Programs in English are now as follows:

GMT	kHz
0230-0300	11935
0430-0500	6025, 11935
1400-1430	21495
1600-1630	17895
1800-1830	11875, 21495
2030-2100	9740

RBI ON 6060kHz

Radio Berlin International has been heard with a new transmitter on 6040kHz, with a Spanish program at 0345-0500GMT. Previous to this is a service in Portuguese from 0300GMT. Reception is fair, but suffers interference from the Voice of America on the same frequency.

According to a report from North America, additional tests have been observed and these include Portuguese to Brazil at 2315-2400 on 6040 and 6065kHz in parallel with 5955, 6010, 9500 and 9600kHz. Spanish is broadcast at 0000 until sign-off at 0045GMT. Further transmissions in Portuguese to Brazil are broadcast at 0300-0345 on 6040, 6070, 9500 and 9600kHz.

RELAYS FROM MALTA

Reception of the Deutsche Welle relay station at Malta has been widely reported on short-wave, but our reception of the medium-wave signals on 1570kHz last year, seems to be the first indication of reception at this distance. Since then the station has been widely received by readers around dawn, and the New Zealand DX Times has given additional information on this station. The station is principally intended for countries surrounding the Mediterranean and the Middle East, but we understand the beam is strongest in the "general direction" of New Zealand. Three 100 metre masts are linked together for the 1570kHz antenna. The current schedule includes: 1400-1750 in German to Near East and Asia, 1800-1850 in Turkish to Southern Europe, 1900-2055 in Arabic to Near East, North Africa.

WINB ON 1518kHz

The Red Lion station WINB which broadcasts gospel programs to Europe has been heard on 15185kHz closing at 2245GMT. This frequency replaces 11775kHz which carried the transmission in the past, but suffered interference from Madrid on the same frequency. The broadcast commences at 1745GMT on 17720kHz and changes to 15185kHz at 1930GMT. The station address is: P.O. Box 88, Red Lion, Pa. U.S.A., 17356.

ENGLISH FROM DELHI

All India Radio provides good reception during the morning listening in this area with a special transmission to Australia and New Zealand from 2045-2215GMT. The frequencies are 7260, 9912 and 11740kHz. A previous broadcast to North Africa at 1945-2045 is now on 9755 and 11880kHz. The transmission from 1000-1100GMT provides best reception on 11755 and 15205kHz. All India Radio welcomes reports from listeners. The address is: P.O. Box 500, Delhi, India.

MEDIUM WAVE NEWS

HAWAII: Station KIOE in Honolulu on 1080kHz has closed, according to Tim Hendel of Honolulu. The station formerly operated on 1090kHz as KHAI. Another Hawaiian Station KPOI on 1380kHz is expected to change to 990kHz shortly, the frequency formerly used by KTRG, which has also closed.

AUSTRALIA: The University of Adelaide station 5UV which tested on 1560kHz when granted its licence, has moved to 530kHz according to Keith Barton of Adelaide. The transmissions are 0830-1130GMT and the program consist of educational instruction. The transmitter power is 600W. The station address is: Radio University, Department of Adult Education, The University of Adelaide, Adelaide, South Australia.

NEW ZEALAND: Since April 1 broadcasting in New Zealand has been under the control of Radio New Zealand after the NZBC was split into three corporations, one for radio and two for television. Major changes have already been announced with the extension of hours of some stations, and a Polynesian radio station to be established in Auckland. Earlier this year two new repeaters came into operation, 4YQ Queenstown on 1120kHz and 2YM Palmerston North on 1410kHz.

The commercial network is now known as Network 1, the former national program is now Network 2, while the former YC program is Network 3. Network 3 will carry good music and has been extended in hours with a breakfast session 1800-2230GMT, on 1YC 880, 2YC 660, 3YC 960 and 4YC 900kHz.

LISTENING BRIEFS
EUROPE

DENMARK: According to "Sweden Calling DXers", after 25 years' service the antennas and masts of Radio Denmark at Herstedvester have deteriorated badly and, since February 15, only two remain in service. These are beamed to Africa, and Greenland/North America, and backwards to the Middle East. Radio Denmark is at present broadcasting on only 15165kHz. In these circumstances reception reports are highly appreciated. The address is: Radio Denmark, Short-wave Department, Broadcasting House, DK-1999 Copenhagen V., Denmark.

HUNGARY: Radio Budapest continues to be heard on its new frequency, 6000kHz, with an English program to sign-off at 0440GMT. Transmitter power is understood to be 500kW. Our reception has been spoilt by other stations on the same frequency.

SWEDEN: Radio Sweden in Stockholm has recently been using 11735kHz with English from 1830-1900GMT beamed to South Asia. The frequency is also used by Radio France and interference is rather severe. Two other frequencies, 11705 and 15240kHz, carry the same program.

INFORMATION CENTRE

ELECTRONIC ANIMALS: I have been a reader of Electronics Australia for some time now, and have enjoyed constructing many of the excellent projects that have been presented in the magazine.

However, as I am primarily interested in bionics (electronic animals etc.), I have noticed the lack of projects along that line in Electronics Australia. The only source material I have been able to obtain is from English magazines.

Unfortunately, back issues of these magazines are often hard to obtain, not to mention the problems involving Australian equivalents for English components. Because of this, do you think you could include some "electronic animal" projects in your magazine in future?

My colleagues and I are in unanimous agreement that Electronics Australia is an excellent magazine. (D.K., Willetton, WA).

Thank you for your comments about the magazine. We are pleased to see that our projects have been to your satisfaction. We have no plans at the present time to develop projects along the lines that you mention, although if interest is sufficiently high, we will certainly consider this possibility.

REPLACEMENT TRANSISTORS: In the December 1973 issue of E.A., Mr. H.B. of Dunolly wanted a replacement transistor for a 2SB494. In the Tandy Electronics Guide (Archer) the replacement listed is a 276-2006 power transistor in a TO-3 case. It retails for $2.30.

I also have transistor troubles—could you tell me of any substitutes for Sanyo 2SB474. It comes out of the output of a 'Monarch SA616 and is in a PT-1 case. Is it PNP or NPN? Does it have any equivalents? Wedderspoon, the importers of Monarch gear, do not know of any SA616, do you? Would it be possible to work out power output from the (four) power transistors mentioned?

Would it be possible to supply me with some data about the 2SB474? Is it silicon or germanium? Have you published a transistor tester for power types such as the 2N3055? Your mag. is great, keep up the good work. (I.K., Dundas, NSW.)

Thank you for your comments about the magazine. As you can see, we have published the data on the 2SB494, for the information of Mr. H.B. We are unable to help with your transistor problem, as it is not listed in any of our data books. We suggest that you contact one of the local transistor manufacturers, who may be able to provide a replacement.

We have not to date published a circuit for a transistor tester expressly for use with power transistors, but you can perform good-bad tests with our Transistor-FET checker of August 1971 (File No. 7/VT/9).

COMPUTER PARTS LIST: I wonder if it is possible to obtain a bulk parts list for the computer project—especially the semiconductors. (C.V., Lindfield, NSW).

By the time this letter appears in print, the computer will have been completed, and all parts lists for the various boards and sections will have been published. Simply collate all the parts lists, and you will have what you require.

IONOSPHERIC PREDICTIONS: I have always been of the opinion that the pictorial representation of ionospheric predictions is by far the best. The old method of representing the predictions of MUF and ALF in graphical form seems to have gone forever due, no doubt, to various reasons. However, these did convey a larger amount of information than the bar graph method. For example: since the ALF is not a sharp cut-off, one could estimate how much loss of signal strength there would be when working below it.

While it is impossible to convey the same amount of information on your bar graph predictions, I would like to suggest an improvement. Where the particular path on a particular frequency is below the MUF, but just below the ALF, the bar could be shown dotted. This would allow the user to discover the difference between a cut-out due to loss of F layer reflection and E layer absorption. (J.A., Preston, Vic.)

The points raised in your letter are similar to those raised several times in the past by both staff and readers. Unfortunately, we are unable to follow this suggestion for a number of reasons.

As you may readily appreciate, the preparation of the ionospheric prediction graph involves a fair amount of time, both for the staff member who does the initial preparation, and for the draughtsman. The graph as it appears in the magazine is not as presented to us by the Ionospheric Prediction Service.

If you are unable to complete an "Electronics Australia" project because you missed out on your regular issue, we can usually provide emergency assistance on the following basis:

PHOTOSTAT COPIES: $2 per project, or $2 per part where a project spreads over multiple issues. Requests can be handled more speedily if projects are positively identified, and if not accompanied by technical queries.

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COMMERCIAL, SURPLUS EQUIPMENT: No information can be supplied.

COMPONENTS: We do not deal in electronic components. Prices, specifications, etc., should be sought from advertisers or agents.

REMITTANCES: Must be negotiable in Australia and made payable to "Electronics Australia". Where the exact charge may be in doubt, we recommend submitting an open cheque endorsed with a suitable limitation.

ADDRESS: All requests to the Assistant Editor, "Electronics Australia", Box 163, Beaconsfield, 2014.

It is prepared from a series of individual graphs contained in booklets and from a number of computer printouts. As this service appeals to only a limited number of readers, we cannot justify additional time spent expanding its format.

In addition, there is a further practical consideration to be made to your suggestion. Where do we select the cut-off point if we were to expand the format along the lines suggested? Such a cut-off point would, at best, be subjective, and could only be made after extensive field investigations. These difficulties would be compounded by the fact that ionospheric prediction is not an exact science anyway.

Obviously, we must have some cut-off point, and for the present format we have chosen those time intervals when it is predicted that the circuit will be open for at least 50 per cent of the month.

200MHz DIGITAL FREQUENCY COUNTER (EA December 1973): I shall be very grateful if you could clarify through your columns the pin connections of ICs 10 and 24 of the above project.

The connections on the printed board (73/c12) appear to be at variance with the circuit diagram on pages 42-43. It has been noted that pins 3 and 14 of IC10 have been transposed in the circuit diagram compared to the printed board. Similarly, pin 2 and pins 10 and 12 of IC24 have been transposed.

I have checked the above with the technical information provided for the ICs, but I am still confused. Perhaps the above does not disturb the function of the instrument, but the counter I built did not function, despite changing the bias resistors. The overflow IC has been connected as per technical data of IC 7473.

Thanking you and awaiting your reply in your good magazine. (P.L., Wondai, Qld.)

The differences that you have detected between the board pattern and the circuit diagram are illusory rather than real. Since the reset function is not being used on IC10, the J and K inputs may be interchanged, the Q and Q-bar outputs also being interchanged to restore the logic function.

This was done to simplify the printed circuit board pattern. As the logic function is not affected, there is no reason why the change should be shown in the circuit.

As you have not supplied any symptoms of the actual faults displayed by your counter, we are unable to provide a positive diagnosis. However, we would like to draw your attention to the errata for this project which were published in the April and June 1974 issues.

VARIABLE FREQUENCY SPEED CONTROL: Could you supply me with a circuit for a variable frequency supply to be used as a speed control on a synchronous motor. I have looked through past editions of the magazine without success. I need a supply rated at 200W, 240V. (K.B., Port Macquarie, NSW).

The reason you couldn't find one is because such a supply has never been published, K.B. However, a tip published in Circuit & Design Ideas some time ago may help: An audio oscillator connected to a very high power audio amplifier thence through a suitable voltage transformer is often useful in applications such as this.

Notes & Errata

DAUBLE (January 1975, File No. 3/MS/50). The parts list contains the following errors. The 120 ohm resistor should be 15 ohms, 1 x 6.8k should read 2 x 6.8k, and 2 x 68k should read 1 x 68k.

FUNCTION GENERATOR (February 1975, File No. 7/AO/22). In the diagram on page 53, the numbering of the wires to the range switch is incorrect. Leads 2 and 5 should be interchanged, as should leads 3 and 4.

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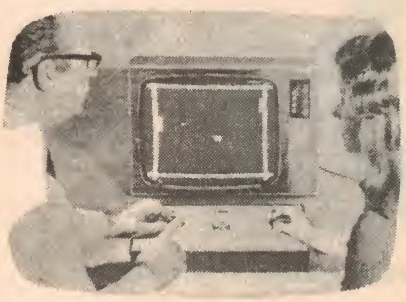

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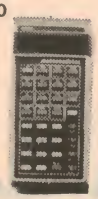

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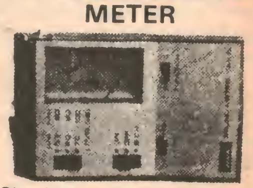

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Genuine Eight Day Jewelled movement, sweep second hand and start of trip indicator. Dash mountings. Ideal for car rallys.
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ILFORD 17.5 mm SPROCKETED MAGNETIC TAPE
1000 ft reels brand new original packing **$4.00 ea.** quantity available
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Genuine ex-army Mk 3, liquid damped, as new **$35.00** P & P $1.05

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100KHz 20MHz **$95**

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Frequency Meters.
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Produces an Audio Signal in rich harmonics. Ideal for Sig Tracing in A.F., I.F., and R.F. circuits. Powered by 4 Penlight Batteries with On-Off Switch and indicator lamp. Size 1 1/2'' Diam. 5'' Long. Only
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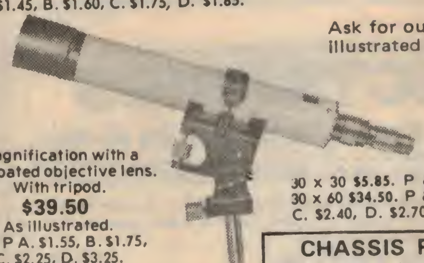

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AN URM 32 A 120 KHz to 1000 MHz, with two 40V power supply, $125.00. $1.00 cartage to rail, freight payable at nearest attended railway station.

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P & P 30c

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A compact and handy tester for workshop or lab where quick circuit checks are required
DC Voltage 5-2.5K (20,000 OHMS per volt) AC Voltage 10-1000V (10,000OHMS per volt) DC Current 0-50 UA. 0-2.5 MA, 0-250 MA. Resistance 0-6 Megohms Capacitance 100 UUF to IUF. Decibels — 20 to plus 22 DB. Complete with instructions.
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1/4'' x 2400' on 10 1/2'' reels. **$4.95**
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Plunger Type 12V 300MA. Suit electric camera control, miniature trains, radio. etc.
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MUSICALITY.
The key to the Success of SANSUI's New AU. Series Stereo Amplifiers.
As Japan's leading audio-only manufacturer, Sansui has always provided the vanguard in amplifier technology, design and development.
Three new models — the AU-5500, AU-6600 and the AU-7700 — combine the latest developments in design with electronic circuitry which produces an audio transparency — **musicality** — impossible to write into technical specifications. This abstract quality must be **heard.**
Power output of the three models range from 70 to 110 watts RMS into 8 ohm speaker systems. Total harmonic distortion is less than 0.15% — the figure for the AU-7700 being less than 0.1%. Frequency response figures are equally outstanding.
Your hi-fi specialist will gladly tell you of all the technical innovations in the new Sansui AU range. Listen **critically** to these new Sansui amplifiers. **Please be quite analytical.** We believe you will confidently select Sansui.
Here are abridged technical specifications.
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Output: 35 watts RMS per channel into 8 ohm speaker systems. **THD:** Less than 0.15%. **Frequency response:** 10-35,000 Hz +0.5, −1 dB. Sensitivity suits magnetic cartridges, tuners, tape decks, etc. **Recommended list price:** $419.
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